FLOAT SEAPLANES

§ 3.273 Landing with inclined reactions.

(a) The vertical component of the limit load factor shall be 4.2 except that it need not exceed a value given by the following formula:

$n = 3.0 + 0.133\ W/S$

(b) The propeller axis (or equivalent reference line) shall be assumed to be horizontal and the resultant water reaction to be acting in the plane of symmetry and passing through the center of gravity of the airplane, but inclined so
that its horizontal component is equal to one fourth of its vertical component. Inertia forces shall be assumed to act in a direction parallel to the water reaction.

(c) Factors of safety. For the design of float attachment members, including the members necessary to complete a rigid brace truss through the fuselage, the factor of safety shall be 1.85. For the remaining structural members, the factor of safety shall be 1.5.

§ 3.275 Landing with vertical reactions.

(a) The limit load factor shall be 4.33 acting vertically, except that it need not exceed a value given by the following formula:

$n = 3.0 + 0.133\ W/S$

(b) The propeller axis (or equivalent reference line) shall be assumed to be horizontal, and the resultant water reaction to be vertical and passing through the center of gravity of the airplane.

(c) Factors of safety. The factors of safety shall be the same as those specified in §3.273(c).

§ 3.277 Landing with side load. The vertical component of the limit load factor shall be 4.0. The propeller axis (or equivalent reference line) shall be assumed to be horizontal and the resultant water reaction shall be assumed to be in the vertical plane which passes through the center of gravity of the airplane and is perpendicular to the propeller axis. The vertical load shall be applied through the keel or keels of the float or floats and evenly divided between the floats when twin floats are used. A side load equal to one-fourth of the vertical load shall be applied along a line approximately halfway between the bottom of the keel and the level of the water line at rest. When twin floats are used, the entire side load specified shall be applied to the float on the side from which the water reaction originates.

§ 3.278 Supplementary load conditions. Each main float of a float seaplane shall be capable of carrying the following loads when supported at the attachment fittings as installed on the airplane:

(a) A limit load, acting upward, applied at the bow end of float and of magnitude equal to that portion of the airplane weight normally supported by the particular float.

(b) A limit load, acting upward, applied at the stern of magnitude equal to 0.8 times that portion of the airplane weight normally supported by the particular float.

(c) A limit load, acting upward, applied at the step and of magnitude equal to 1.5 times that portion of the airplane weight normally supported by the particular float.

§ 3.279 Bottom loads.

(a) Main seaplane float bottoms shall be designed to withstand the following local pressures:

(1) A limit pressure of at least 10 pounds per square inch over that portion of the bottom lying between the first step and a section 25 percent of the distance from the step to the bow.

(2) A limit pressure of at least 5 pounds per square inch over that portion of the bottom lying between the section 25 percent of the distance from the strip to the bow and a section 75 percent of the distance from the step to the bow.

(3) A limit pressure of at least 3 pounds per square inch over that portion of the bottom aft of the step (aft of main step if more than one step is used).

(b) The local pressures determined in paragraph (a) (1), (2) and (3) of this section shall be applied over local areas in such a manner as to cause the maximum loads in local structure such as bottom plating and stringers.

(c) For the purpose of designing frames, keels, and chine structure, distributed bottom pressures equal to one-half of the local values specified above shall be applied over the entire specified bottom areas.

WING-TIP FLOAT AND SEA WING LOADS

§ 3.280 Wing-tip float loads. Wing-tip floats and their attachment, including the wing structure, shall be analyzed for each of the following conditions:

(a) A limit load acting vertically up at the completely submerged center of buoyancy and equal to 3 times the completely submerged displacement.

(b) A limit load inclined upward at 45 degrees to the rear and acting through the completely submerged center of buoyancy and equal to 3 times the completely submerged displacement.

(c) A limit load acting parallel to the water surface (laterally) applied at the center of area of the side view and equal to 1.5 times the completely submerged displacement.

§ 3.281 Wing structure. The primary wing structure shall incorporate sufficient extra strength to insure that failure of wing-tip float attachment members occurs before the wing structure is damaged.

§ 3.282 Sea wing loads. Sea wing design loads shall be based on suitable test data.

SUBPART D—DESIGN AND CONSTRUCTION
GENERAL

§ 3.291 General. The suitability of all questionable design details or parts having an important bearing on safety in operation shall be established by tests.

§ 3.292 Materials and workmanship. The suitability and durability of all materials used in the airplane structure shall be established on the basis of experience or tests. All materials used in the airplane structure shall conform to approved specifications which will insure their having the strength and other properties assumed in the design data. All workmanship shall be of a high standard.

§ 3.293 Fabrication methods. The methods of fabrication employed in constructing the airplane structure shall be such as to produce consistently sound structure. When a fabrication process such as gluing, spot welding, or heat-treating requires close control to attain this objective, the process shall be performed in accordance with an approved process specification.

§ 3.294 Standard fastenings. All bolts, pins, screws, and rivets used in the structure shall be of an approved type. The use of an approved locking device or method is required for all such bolts, pins, and screws. Self-locking nuts shall not be used on bolts subject to rotation during the operation of the airplane.

§ 3.295 Protection. All members of the structure shall be suitably protected against deterioration or loss of strength in service due to weathering, corrosion, abrasion, or other causes. In seaplanes, special precaution shall be taken against corrosion from salt water, particularly where parts made from different metals are in close proximity. Adequate provisions for ventilation and drainage of all parts of the structure shall be made.

§ 3.296 Inspection provisions. Adequate means shall be provided to permit the close examination of such parts of the airplane as require periodic inspection, adjustments for proper alignment and functioning, and lubrication of moving parts.

STRUCTURAL PARTS

§ 3.301 Material strength properties and design values. Material strength properties shall be based on a sufficient number of tests of material conforming to specifications to establish design values on a statistical basis. The design values shall be so chosen that the probability of any structure being understrength because of material variations is extremely remote. Values contained in ANC-5 and ANC-18 shall be used unless shown to be inapplicable in a particular case.

Note: ANC-5, "Strength of Aircraft Elements" and ANC-18, "Design of Wood Aircraft Structures" are published by the Army-Navy-Civil Committee on Aircraft Design Criteria and may be obtained from the Government Printing Office, Washington 25, D.C.

§ 3.302 Special factors. Where there may be uncertainty concerning the actual strength of particular parts of the structure or where the strength is likely to deteriorate in service prior to normal replacement, increased factors of safety shall be provided to insure that the reliability of such parts is not less than the rest of the structure as specified in §§ 3.303-3.306.

§ 3.303 Variability factor. For parts whose strength is subject to appreciable variability due to uncertainties in manufacturing processes and inspection methods, the factor of safety shall be increased sufficiently to make the probability of any part being under-strength from this cause extremely remote. Minimum variability factors (only the highest pertinent variability factor need be considered) are set forth in §§ 3.304-3.306.

§ 3.304 Castings.

(a) Where visual inspection only is to be employed, the variability factor shall be 2.0.

(b) The variability factor may be reduced to 1.25 for ultimate loads and 1.15 for limit loads when at least three sample castings are tested to show compliance with these factors, and all sample and production castings are visually and radiographically inspected in accordance with an approved inspection specification.

(c) Other inspection procedures and variability factors may be used if found satisfactory by the Administrator.

§ 3.305 Bearing factors.

(a) The factor of safety in bearing at bolted or pinned joints shall be suitably increased to provide for the following conditions:

(1) Relative motion in operation (control surface and system joints are covered in §§ 3.327-3.347).

(2) Joints with clearance (free fit) subject to pounding or vibration.

(b) Bearing factors need not be applied when covered by other special factors.

§ 3.306 Fitting factor. Fittings are denied as parts such as end terminals used to join one structural member to another. A multiplying factor of safety of at least 1.15 shall be used in the analysis of all fittings the strength of which is not proved by limit and ultimate load tests in which the actual stress conditions are simulated in the fitting and the surrounding structure. This factor applies to all portions of the fitting, the means of attachment, and bearing on the members joined. In the case of integral fittings, the part shall be treated as a fitting up to the point where the section properties become typical of the member. The fitting factor need not be applied where a type of joint design based on comprehensive test data is used. The following are examples: continuous joints in metal plating, welded joints, and scarf joints in wood, all made in accordance with approved practices.

§ 3.307 Fatigue strength. The structure shall be designed, insofar as practicable, to avoid points of stress concentration where variable stresses above the fatigue limit are likely to occur in normal service.

FLUTTER AND VIBRATION

§ 3.311 Flutter and vibration prevention measures. Wings, tail, and control surfaces shall be free from flutter, airfoil divergence, and control reversal from lack of rigidity, for all conditions of operation within the limit V-n envelope, and the following detail requirements shall apply:

(a) Adequate wing torsional rigidity shall be demonstrated by tests or other methods found suitable by the Administrator.

(b) The mass balance of surfaces shall be such as to preclude flutter.

(c) The natural frequencies of all main structural components shall be determined by vibration tests or other methods found satisfactory by the Administrator.

WINGS

§ 3.317 Proof of strength. The strength of stressed-skin wings shall be substantiated by load tests or by combined structural analysis and tests.

[§ 3.318 Ribs. Rib tests shall simulate conditions in the airplane with respect to torsional rigidity of spars, fixity conditions, lateral support, and attachment to spars. The effects of ailerons and high lift devices shall be properly accounted for.**]**

§ 3.319 External bracing. **[**Rescinded.**]**

§ 3.320 Covering. **[**Rescinded.**]**

CONTROL SURFACES (FIXED AND MOVABLE)

§ 3.327 Proof of strength. Limit load tests of control surfaces are required. Such tests shall include the horn or fitting to which the control system is attached. In structural analyses, rigging loads due to wire bracing shall be taken into account in a rational or conservative manner.

§ 3.328 Installation. Movable tail surfaces shall be so installed that there is no interference between the surfaces or their bracing when each is held in its extreme position and all others are operated through their full angular movement.
When an adjustable stabilizer is used, stops shall be provided which, in the event of failure of the adjusting mechanism, will limit its travel to a range permitting safe flight and landing.

§ 3.329 Hinges. Control surface hinges, excepting ball and roller bearings, shall incorporate a multiplying factor of safety of not less than 6.67 with respect to the ultimate bearing strength of the softest material used as a bearing. For hinges incorporating ball or roller bearings, the approved rating of the bearing shall not be exceeded. Hinges shall provide sufficient strength and rigidity for loads parallel to the hinge line.

CONTROL SYSTEMS

§ 3.335 General. All controls shall operate with sufficient ease, smoothness, and positiveness to permit the proper performance of their function and shall be so arranged and identified as to provide convenience in operation and prevent the possibility of confusion and subsequent inadvertent operation. (See § 3.384 for cockpit controls.)

§ 3.336 Primary flight controls.

(a) Primary flight controls are defined as those used by the pilot for the immediate control of the pitching, rolling, and yawing of the airplane.

(b) For two-control airplanes the design shall be such as to minimize the likelihood of complete loss of the lateral directional control in the event of failure of any connecting or transmitting element in the control system.

§ 3.337 Trimming controls. Proper precautions shall be taken against the possibility of inadvertent, improper, or abrupt tab operations. Means shall be provided to indicate to the pilot the direction of control movement relative to airplane motion and the position of the trim device with respect of the range of adjustment. The means used to indicate the direction of the control movement shall be adjacent to the control, and the means used to indicate the position of the trim device shall be easily visible to the pilot and so located and operated as to preclude the possibility of confusion. Trimming devices shall be capable of continued normal operation notwithstanding the failure of any one connecting or transmitting element in the primary flight control system. Tab controls shall be irreversible unless the tab is properly balanced and possesses no unsafe flutter characteristics. Irreversible tab systems shall provide adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the airplane structure.

§ 3.338 Wing flap controls. The controls shall be such that when the flap has been placed in any position upon which compliance with the performance requirements is based, the flap will not move from that position except upon further adjustment of the control or the automatic operation of a flap load limiting device. Means shall be provided to indicate the flap position to the pilot. If any flap position other than fully retracted or extended is used to show compliance with the performance requirements, such means shall indicate each such position. The rate of movement of the flaps in response to the operation of the pilot's control, or of an automatic device shall not be such as to result in unsatisfactory flight or performance characteristics under steady or changing conditions of air speed, engine power, and airplane attitude (See § 3.109 (b) and (c).)

§ 3.339 Flap interconnection.

(a) The motion of flaps on opposite sides of the plane of symmetry shall be synchronized by a mechanical interconnection, unless the airplane is demonstrated to have safe flight characteristics while the flaps are retracted on one side and extended on the other.

(b) Where an interconnection is used, in the case of multiengine airplanes, it shall be designed to account for the unsymmetrical loads resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at take-off power. For single engine airplanes, it may be assumed that 100 percent of the critical air load acts on one side and 70 percent on the other.

§ 3.340 Stops. All control systems shall be provided with stops which positively limit the range of motion of the control surfaces. Stops shall be so located in the system that wear, slackness, or take-up adjustments will not appreciably affect the range of surface travel. Stops shall be capable of withstanding the loads corresponding to the design conditions for the control system.

§ 3.341 Control system locks. When a device is provided for locking a control surface while the airplane is on the ground or water:

(a) The locking device shall be so installed as to provide unmistakable warning to the pilot when it is engaged, and

(b) Means shall be provided to preclude the possibility of the lock becoming engaged during flight.

§ 3.342 Proof of strength. Tests shall be conducted to prove compliance with limit load requirements. The direction of test loads shall be such as to produce the most severe loading of the control system structure. The tests shall include all fittings, pulleys, and brackets used to attach the control system to the primary structure. Analyses or individual load tests shall be conducted to demonstrate compliance with the multiplying factor of safety requirements specified for control system joints subjected to angular motion.

§ 3.343 Operation test. An operation test shall be conducted by operating the controls from the pilot compartment with the entire system so loaded as to correspond to the limit air loads on the surface. In this test there shall be no jamming, excessive friction, or excessive deflection.

CONTROL SYSTEM DETAILS

§ 3.344 General. All control systems and operating devices shall be so designed and installed as to prevent jamming, chafing, or interference as a result of inadequate clearances or from cargo, passengers, or loose objects. Special precautions shall be provided in the cockpit to prevent the entry of foreign objects into places where they might jam the controls. Provisions shall be made to prevent the slapping of cables or tubes against parts of the airplane.

§ 3.345 Cable systems. Cables, cable fittings, turnbuckles, splices, and pulleys shall be in accordance with approved specifications. Cables smaller than 1/8-inch diameter shall not be used in primary control systems. The design of cable systems shall be such that there will not be hazardous change in cable tension throughout the range of travel under operating conditions and temperature variations. Pulley types and sizes shall correspond to the cables with which they are used, as specified on the pulley specification. All pulleys shall be provided with satisfactory guards which shall be closely fitted to prevent the cables becoming misplaced or fouling, even when slack. The pulleys shall lie in the plane passing through the cable within such limits that the cable does not rub against the pulley flange. Fairleads shall be so installed that they are not required to cause a change in cable direction of more than 3 degrees. Clevis pins (excluding those not subject to load or motion) retained only by cotter pins shall not be employed in the control system. Turnbuckles shall be attached to parts having angular motion in such a manner as to prevent positively binding throughout the range of travel. Provisions for visual inspection shall be made at all fairleads, pulleys, terminals, and turnbuckles.

§ 3.346 Joints. Control system joints subject to angular motion in push-pull systems, excepting ball and roller bearing systems, shall incorporate a multiplying factor of safety of not less than 3.33 with respect to the ultimate bearing strength of the softest material used as a bearing. This factor may be reduced to 2.0 for such joints in cable control systems. For ball or roller bearings the approved rating of the bearing shall not be exceeded.

§ 3.347 Spring devices. The reliability of any spring devices used in the control system shall be established by tests simulating service conditions, unless it is demonstrated that failure of the spring will not cause flutter or unsafe flight characteristics.

LANDING GEAR
SHOCK ABSORBERS

§ 3.351 Tests. Shock absorbing elements in main, nose, and tail wheel units shall be substantiated by the tests specified in the following section. In addition, the shock absorbing ability of the landing gear in taxiing must be demonstrated in the operational tests of § 3.146.

§ 3.352 Shock absorption tests.

(a) It shall be demonstrated by energy absorption tests that the limit load factors selected for design in accordance with § 3.243 will not be exceeded in landings with the limit descent velocity specified in that section.

(b) In addition, a reserve of energy absorption shall be demonstrated by a test in which the descent velocity is at least 1.2 times the limit descent velocity. In this test there shall be no failure of the shock aborting unit, although yielding of the unit will be permitted. Wing lift equal to the weight of the airplane may be assumed for purposes of this test.

§ 3.353 Limit drop tests.

(a) If compliance with the specified limit landing conditions of § 3.352 (a) is demonstrated by free drop tests, these shall be conducted on the complete airplane, or on units consisting of wheel, tire, and shock absorber in their proper relation, from free drop heights not less than the following:

$$h \text{ (inches)} = 3.6\,(W/S)^{0.5}$$

except that the free drop height shall not be less than 9.2 inches and need not be greater than 18.7 inches.

(b) In simulating the permissible wing lift in free drop tests, the landing gear unit shall be dropped with an effective mass equal to:

$$W_e = W \frac{h+(1-L)d}{h+d}$$

where
We = the effective weight to be used in the drop test.
h = specified height of drop in inches.
d = deflection under impact of the tire (at the approved inflation pressure) plus the vertical component of the axle travel relative to the drop mass. The value of d used in the computation of *We* shall not exceed the value actually obtained in the drop tests.
$W = W_M$ or main gear units, and shall be equal to the static weight on the particular unit with the airplane in the level attitude (with the nose wheel clear, in the case of nose wheel clear, in the case of nose wheel type airplanes).
$W = W_T$ for tail gear units, and shall be equal to the static weight on the tail unit with the airplane in the tail down attitude.
$W = W_N$ for nose wheel units, and shall be equal to the static reaction which will exist at the nose wheel when the mass of the airplane is concentrated at the center of gravity and exerts a force of 1.0g downward and 0.33g forward.
L = ratio of assumed wing lift to airplane weight, not greater than 0.667.

The attitude in which the landing gear unit is drop tested shall be such as to simulate the airplane landing condition which is critical from the standpoint of energy to be absorbed by the particular unit.

§ 3.354 Limit load factor determination. In determining the limit airplane inertia load factor n from the free drop test described above, the following formula shall be used:

$$n = n_j \frac{W_e}{W} + L$$

where
nj = the load factor developed in the drop test, i.e., the acceleration (dv/dt) in g’s recorded in the drop test, plus 1.0.

The value of n so determined shall not be greater than the limit inertia load factor used in the landing conditions, § 3.243.

§ 3.355 Reserve energy absorption drop tests. If compliance with the reserve energy absorption condition specified in § 3.352 (b) is demonstrated by free drop tests, the drop height shall be not less than 1.44 times the drop height
specified in § 3.353. In simulating wing lift equal to the airplane weight, the units shall be dropped with an effective mass equal to

$$W_e = W \frac{h}{h+d}$$

where the symbols and other details are the same as in § 3.353.

RETRACTING MECHANISM

§ 3.356 General. The landing gear retracting mechanism and supporting structure shall be designed for the maximum load factors in the flight conditions when the gear is in the retracted position. It shall also be

designed for the combination of friction, inertia, brake torque, and air loads occurring during retraction at any air speed up to 1.6Vs1, flaps retracted and any load factors up to those specified for the flaps extended condition, § 3.190. The landing gear
and retracting mechanism, including the wheel well doors, shall withstand flight loads with the landing gear extended at any speed up to at least 1.6 Vs1 flaps retracted. Positive means shall be provided for the purpose of maintaining the
wheels in the extended position.

§ 3.357 Emergency operation. When other than manual power for the operation of the landing gear is employed, an auxiliary means of extending the landing gear shall be provided.

§ 3.358 Operation test. Proper functioning of the landing gear retracting mechanism shall be demonstrated by operation tests.

§ 3.359 Position indicator and warning device. When retractable landing wheels are used, means shall be provided for indicating to the pilot when the wheels are secured in the extreme positions. In addition, landplanes shall be provided with an aural or equally effective warning device which shall function continuously after the throttle is closed until the gear is down and locked.

§ 3.360 Control. See § 3.384.

WHEELS AND TIRES

§ 3.361 Wheels.

(a) Main landing gear wheels (i.e., those nearest the airplane center of gravity) shall be of an approved type.

(b) The rated static load of each main wheel shall not be less than the design weight for ground loads (§ 3.242) divided by the number of main wheels. Nose wheels shall have been tested for an ultimate radial load not less than the maximum nose wheel ultimate load obtained in the ground loads requirements, and for corresponding side and burst loads.

§ 3.362 Tires. A landing gear wheel may be equipped with any make or type of tire, provided that the approved tire rating is not exceeded under the following conditions:

(a) Load on main wheel tires equal to the airplane weight divided by the number of wheels,

(b) Load on nose wheel tires (to be compared with the dynamic rating established for such tires) equal to the reaction obtained at the nose wheel, assuming the mass of the airplane concentrated at the center of gravity and exerting a force of 1.0g downward and 0.31g forward, the reactions being distributed to the nose and main wheels by the principle of statics with the drag reaction at the ground applied only at those wheels having brakes. When specially constructed tires are used to support an airplane, the wheels shall be plainly and conspicuously marked to that effect. Such marking shall include the make, size, number of plies, and identification marking of the proper tire.

Note: Approved ratings are those assigned by the Tire and Rim Association or by the Administrator.

BRAKES

§ 3.363 Brakes. Brakes shall be installed which are adequate to prevent the airplane from rolling on a paved runway while applying take-off power to the critical engine, and of sufficient capacity to provide adequate speed control
during taxiing without the use of excessive pedal or hand forces.

SKIS

§ 3.364 Skis. Skis shall be of an approved typed. The approved rating of the skis shall not be less than the maximum weight of the airplane on which they are installed.

§ 3.365 Installation.

(a) When type certificated skis are installed, the installation shall be made in accordance with the ski or airplane manufacturer's recommendations which shall have been approved by the Administrator. When other than type certificated skis are installed, data shall be submitted to the Administrator showing a dimensional drawing of the proposed method of attaching the skis, the sizes and material of the restraining members and attachment fittings.

(b) In addition to such shock cord(s) as may be provided, front and rear check cables shall be used on skis not equipped with special stabilizing devices.

§ 3.366 Tests.

(a) If the airplane is of a model not previously approved with the specific ski installation, it shall satisfactorily pass a ground inspection of the installation, demonstrate satisfactory landing and taxiing characteristics, and comply with such flight tests as are found necessary to indicate that the airplane's flight characteristics are satisfactory with the skis installed.

(b) If the airplane is of a model previously approved with the specific ski installation, it need pass satisfactorily only a ground inspection of the installation.

HULLS AND FLOATS

§ 3.371 Buoyancy (main seaplane floats).

(a) Main seaplane floats shall have a buoyancy in excess of that required to support the maximum weight of the airplane in fresh water as follows:

(1) 80 percent in the case of single floats.

(2) 90 percent in the case of double floats.

(b) Main seaplane floats for use on airplanes of 2,500 pounds or more maximum weight shall contain at least 5 watertight compartments of approximately equal volume. Main seaplane floats for use on airplanes of less than 2,500 pounds maximum weight shall contain at least four such compartments.

§ 3.372 Buoyancy (boat seaplanes). The hulls of boat seaplanes and amphibians shall be divided into watertight compartments in accordance with the following requirements:

(a) In airplanes of 5,000 pounds or more maximum weight, the compartments shall be so arranged that, with any two adjacent compartments flooded, the hull and auxiliary floats (and tires, if used) will retain sufficient buoyancy to support the maximum weight of the airplane in fresh water.

(b) In airplanes of 1,500 to 5,000 pounds maximum weight, the compartments shall be so arranged that, with any one compartment flooded, the hull and auxiliary floats (and tires, if used) will retain sufficient buoyancy to support the maximum weight of the airplane in fresh water.

(c) In airplanes of less than 1,500 pounds maximum weight, watertight subdivision of the hull is not required.

(d) Bulkheads may have watertight doors for the purpose of communication between compartments.

§ 3.373 Water stability. Auxiliary floats shall be so arranged that when completely submerged in fresh water, they will provide a righting moment which is at least 1.5 times the upsetting moment caused by the airplane being tilted. A greater degree of stability may be required by the Administrator in the case of large flying boats, depending on the height of the center of gravity above the water level, the area and location of wings and tail surfaces, and other considerations.

FUSELAGE
PILOT COMPARTMENT

§ 3.381 General.

(a) The arrangement of the pilot compartment and its appurtenances shall provide a satisfactory degree of safety and assurance that the pilot will be able to perform all his duties and operate the controls in the correct manner without unreasonable concentration and fatigue.

(b) The primary flight control units listed on Figure 3-14, excluding cables and control rods, shall be so located with respect to the propellers that no portion of the pilot or controls lies in the region between the plane of rotation of any inboard propeller and the surface generated by a line passing through the center of the propeller hub and making an angle of 5° forward or aft of the plane of rotation of the propeller.

§ 3.382 Vision. The pilot compartment shall be arranged to afford the pilot a sufficiently extensive, clear, and undistorted view for the safe operation of the airplane. During flight in a moderate rain condition, the pilot shall have an adequate view of the flight path in normal flight and landing, and have sufficient protection from the elements so that his vision is not unduly impaired. This may be accomplished by providing an openable window or by a means for maintaining a portion of the windshield in a clear condition without continuous attention by the pilot. The pilot compartment shall be free of glare and reflections which would interfere with the pilot's vision. For airplanes intended for night operation, the demonstration of these qualities shall include night flight tests.

§ 3.383 Pilot windshield and windows. All glass panes shall be of a nonsplintering safety type.

§ 3.384 Cockpit controls.

(a) All cockpit controls shall be so located and, except for those the function of which is obvious, identified as to provide convenience in operation including provisions to prevent the possibility of confusion and consequent inadvertent operations. (See Fig. 3-14 for required sense of motion of cockpit controls.) The controls shall be so located and arranged that when seated it will be readily possible for the pilot to obtain full and unrestricted movement of each control without interference form either his clothing or the cockpit structure.

(b) Identical power-plant controls for the several engines in the case of multiengine airplanes shall be so located as to prevent any misleading impression as to the engines of which they relate.

Control	Movement and actuation
Primary:	
Aileron	Right (clockwise) for right wing down.
Elevator	Rearward for nose up.
Rudder	Right pedal forward for nose right.
Power plant:	
Throttle	Forward to open.

Figure 3-14 Cockpit Controls

§ 3.385 Instruments and markings. See § 3.661 relative to instrument arrangement. The operational markings, instructions, and placards required for the instruments and controls are specified in §§ 3.756 to 3.765.

EMERGENCY PROVISIONS

§ 3.386 Protection. The fuselage shall be designed to give reasonable assurance that each occupant, if he makes proper use of belts or harness for which provisions are made in the design, will not suffer serious injury during minor crash conditions as a result of contact of any vulnerable part of his body with any penetrating or relatively solid object, although it is accepted that parts of the airplane may be damaged.

(a) The ultimate accelerations to which occupants are assumed to be subjected shall be as follows:

	N, U	A
Upward	3.0g	4.5g
Forward	9.0g	9.0g
Sideward	1.5g	1.5g

(b) For airplanes having retractable landing gear, the fuselage in combination with other portions of the structure shall be designed to afford protection of the occupants in a wheels-up landing with moderate descent velocity.

(c) If the characteristics of an airplane are such as to make a turn-over reasonably probable, the fuselage of such an airplane in combination with other portions of the structure shall be designed to afford protection of the occupants in a complete turn-over.

Note: In § 3.386 (b) and (c), a vertical ultimate acceleration of 3g and a friction coefficient of 0.5 at the ground may be assumed.

§ 3.387 Exits.

(a) Closed cabins on airplanes carrying more than 5 persons shall be provided with emergency exits consisting of movable windows or panels or of additional external doors which provide a clear and unobstructed opening, the minimum dimensions of which shall be such that a 19-by-26-inch ellipse may be completely inscribed therein. The exits shall be readily accessible, shall not require exceptional agility of a person using them, and shall be distributed so as to facilitate egress without crowding in all probable attitudes resulting from a crash. The method of opening shall be simple and obvious, and the exits shall be so arranged and marked as to be readily located and operated even in darkness. Reasonable provisions shall be made against the jamming of exits as a result of fuselage deformation. The proper functioning of exits shall be demonstrated by tests.

(b) The number of emergency exits required is as follows:

(1) Airplanes with a total seating capacity of more than 5 persons, but not in excess of 15, shall be provided with at least one emergency exit or one suitable door in addition to the main door specified in § 3.389. This emergency exit, or second door, shall be on the opposite side of the cabin from the main door.

(2) Airplanes with a seating capacity of more than 15 persons shall be provided with emergency exits or doors in addition to those required in paragraph (b) (1) of this section. There shall be one such additional exit or door located either in the top or side of the cabin for every additional 7 persons or fraction thereof above 15, except that not more than four exits, including doors, will be required if the arrangement and dimensions are suitable for quick evacuation of all occupants.

(c) If the pilot compartment is separated from the cabin by a door which is likely to block the escape in the event of a minor crash, it shall have its own exit, but such exit shall not be considered as an emergency exit for the passengers.

(d) In categories U and A exits shall be provided which will permit all occupants to bail out quickly with parachutes.

§ 3.388 Fire precautions—

(a) Cabin interiors. Only materials which are flash resistant shall be used. In compartments where smoking is to be permitted, the materials of the cabin lining, floors, upholstery, and furnishings shall be flame-resistant. Such compartments shall be equipped with an adequate number of self contained ash trays. All other compartments shall be placarded against smoking.

(b) Combustion heaters. Gasoline operated combustion heater installations shall comply with applicable parts of the power-plant installation requirements covering fire hazards and precautions. All applicable requirements concerning fuel tanks, lines, and exhaust systems shall be considered.

PERSONNEL AND CARGO ACCOMMODATIONS

§ 3.389 Doors. Closed cabins on all airplanes carrying passengers shall be provided with at least one adequate and easily accessible external door. No passenger door shall be so located with respect to the propeller discs as to endanger persons using the door.

§ 3.390 Seats and berths—

(a) Passenger seats and berths. All seats and berths and supporting structure shall be designed for a passenger weight of 170 pounds (190 pounds with parachute for the acrobatic and utility categories) and the maximum load factors corresponding to all specified flight and ground load conditions including the emergency conditions of § 3.386. **[**The accelerations prescribed in § 3.386 shall be multiplied by a factor of 1.33 for determining the strength of the seat and berth attachments to the structure.**]**

(b) Pilot seats. Pilot seats shall be designed for the reactions resulting from the application of the pilot forces to the primary flight controls as specified in § 3.231.

(c) Categories U and A. All seats designed to be occupied in the U and A categories under §3.74 (c) (4) shall be designed to accommodate passengers wearing parachutes.

§ 3.391 Safety belt or harness provisions. Provisions shall be made at all seats and berths for the installation of belts or harness of sufficient strength to comply with the emergency conditions of § 3.386.**[**The accelerations prescribed in § 3.386 shall be multiplied by a factor of 1.33 for determining the strength of the belt anchorages to the seat or to the structure. **]**

§ 3.392 Cargo compartments. Each cargo compartment shall be designed for the placarded maximum weight of contents and critical load distributions at the appropriate maximum load factors corresponding to all specified flight and ground load conditions. Suitable provisions shall be made to prevent the contents of cargo compartments form becoming a hazard by shifting. Such provisions shall be adequate to protect the passengers from injury by the contents of any cargo compartment when the ultimate forward acting accelerating force is 4.5g.

§ 3.393 Ventilation. All passenger and crew compartments shall be suitably ventilated. Carbon monoxide concentration shall not exceed 1 part in 20,000 parts of air.

MISCELLANEOUS

§ 3.401 Leveling marks. Leveling marks shall be provided for leveling the airplane on the ground.

SUBPART E—POWER-PLANT INSTALLATIONS; RECIPROCATING ENGINES

GENERAL

§ 3.411 Components.

(a) The power plant installation shall be considered to include all components of the airplane which are necessary for its propulsion. It shall also be considered to include all components which affect the control of the major propulsive units or which affect their continued safety of operation.

(b) All components of the power-plant installation shall be constructed, arranged, and installed in a manner which will assure the continued safe operation of the airplane and power plant. Accessibility shall be provided to permit such inspection and maintenance as is necessary to assure continued airworthiness.

ENGINES AND PROPELLERS

§ 3.415 Engines. Engines installed in certificated airplanes shall be of a type which has been certificated in accordance with the provisions of Part 13 of this chapter.

§ 3.416 Propellers.

(a) Propellers installed in certificated airplanes shall be of a type which has been certificated in accordance with the provisions of Part 14 of this chapter.

(b) The maximum engine power and propeller shaft rotational speed permissible for use in the particular airplane involved shall not exceed the corresponding limits for which the propeller has been certificated.

§ 3.417 Propeller vibration. **[**In the case of propellers with metal blades or other highly stressed metal components, the magnitude of the critical vibration stresses under all normal conditions of operation shall be determined by actual measurements or by comparison with similar installations for which such measurements have been made.**]** The vibration stresses thus determined shall not exceed values which have been demonstrated to be safe for continuous operation. Vibration tests may be waived and the propeller installation accepted on the basis of service experience, engine or ground tests which show adequate margins of safety, or other considerations which satisfactorily substantiate its safety in this respect. In addition to metal propellers, the Administrator may require that similar substantiation of the vibration characteristics be accomplished for other types of propellers, with the exception of conventional fixed-pitch wood propellers.

§ 3.418 Propeller pitch and speed limitations. The propeller pitch and speed shall be limited to values which will assure safe operation under all normal conditions of operation and will assure compliance with the performance requirements specified in §§ 3.81-3.86.

§ 3.419 Speed limitations for fixed-pitch propellers, ground adjustable pitch propellers, and automatically varying pitch propellers which cannot be controlled in flight,

(a) During take-off and initial climb at best rate-of-climb speed, the propeller, in the case of fixed pitch or ground adjustable types, shall restrain the engine to a speed not exceeding its maximum permissible take-off speed and, in the case of automatic variable-pitch types, shall limit the maximum governed engine revolutions per minute to a speed not exceeding the maximum permissible take-off speed. In demonstrating compliance with this provision the engine shall be operated at full throttle or the throttle setting corresponding to the maximum permissible takeoff manifold pressure.

(b) During a closed throttle glide at the placard, "never-exceed speed" (see § 3.739), the propeller shall not cause the engine to rotate at a speed in excess of 110 percent of its maximum allowable continuous speed.

§ 3.420 Speed and pitch limitations for controllable pitch propellers without constant speed controls. The stops or other means incorporated in the propeller mechanism to restrict the pitch range shall limit

(a) the lowest possible blade pitch to a value which will assure compliance with the provisions of § 3.419 (a), and

(b) the highest possible blade pitch to a value not lower than the flattest blade pitch with which compliance with the provisions of § 3.419 (b) can be demonstrated.

§ 3.421 Variable pitch propellers with constant speed controls.

(a) Suitable means shall be provided at the governor to limit the speed of the propeller. Such means shall limit the maximum governed engine speed to a value not exceeding its maximum permissible take-off revolutions per minute.

(b) The low pitch blade stop, or other means incorporated in the propeller mechanism to restrict the pitch range, shall limit the speed of the engine to a value not exceeding 103 percent of the maximum permissible take-off revolutions per minute under the following conditions:

(1) Propeller blade set in the lowest possible pitch and the governor inoperative.

(2) Engine operating at take-off manifold pressure with the airplane stationary and with no wind.

§ 3.422 Propeller clearance. With the airplane loaded to the maximum weight and most adverse center of gravity position and the propeller in the most adverse pitch position, propeller clearances shall not be less than the following, unless smaller clearances are properly substantiated for the particular design involved:

(a) Ground clearance.

(1) Seven inches (for airplanes equipped with nose wheel type landing gears) or 9 inches (for airplanes equipped with tail wheel type landing gears) with the landing gear statically deflected and the airplane in the level normal take-off, or taxiing attitude, whichever is most critical.

(2) In addition to subparagraph (1) of this paragraph, there shall be positive clearance between the propeller and the ground when, with the airplane in the level take-off attitude, the critical tire is completely deflated and the corresponding landing gear strut is completely bottomed.

(b) Water clearance. A minimum clearance of 18 inches shall be provided unless compliance with § 3.147 can be demonstrated with lesser clearance.

(c) Structural clearance.

(1) One inch radial clearance between the blade tips and the airplane structure, or whatever additional radial clearance is necessary to preclude harmful vibration of the propeller or airplane.

(2) One-half inch longitudinal clearance between the propeller blades or cuffs and stationary portions of the airplane. Adequate positive clearance shall be provided between other rotating portions of the propeller or spinner and stationary portions of the airplane.

FUEL SYSTEM

§ 3.429 General. The fuel system shall be constructed and arranged in a manner to assure the provision of fuel to each engine at a flow rate and pressure adequate for proper engine functioning under all normal conditions of operation, including all maneuvers and acrobatics for which the airplane is intended.

ARRANGEMENT

§ 3.430 Fuel system arrangement. Fuel systems shall be so arranged as to permit any one fuel pump to draw fuel from only one tank at a time. Gravity feed systems shall not supply fuel to any one engine from more than one tank at a time unless the tank air spaces are interconnected in such a manner as to assure that all interconnected tanks will feed equally. (See also§ 3.439.)

[§ 3.431 Multiengine fuel system arrangement . The fuel systems of multiengine airplanes which are required to comply with the provisions of § 3.85 (b) shall be arranged to permit operation in at least one configuration in such a manner that the failure of any one component will not result in the loss of power of more than one engine and will not require immediate action by the pilot to prevent the loss of power of more than one engine. Unless other provisions are made to comply with this requirement, the fuel system shall be arranged to permit supplying fuel to each engine through a system entirely independent of any portion of the system supplying fuel to the other engines. Other multiengine airplanes shall also comply with the requirement except that separate fuel tanks need not be provided for each engine.**]**

§ 3.432 Pressure cross feed arrangements. Pressure cross feed lines shall not pass through portions of the airplane devoted to carrying personnel or cargo, unless means are provided to permit the flight personnel to shut off the supply of fuel to these lines, or unless any joints, fittings, or other possible sources of leakage installed in such lines are enclosed in a fuel- and fume-proof enclosure which is ventilated and drained to the exterior of the airplane. Bare tubing need not be enclosed but shall be protected where necessary against possible inadvertent damage.

OPERATION

§ 3.433 Fuel flow rate. The ability of the fuel system to provide the required fuel flow rate and pressure shall be demonstrated when the airplane is in the attitude which represents the most adverse condition from the standpoint of fuel feed and quantity of unusable fuel in the tank. During this test fuel shall be delivered to the engine at the applicable flow rate (see §§ 3.434-3.436) and at a pressure not less than the minimum required for proper carburetor operation. A suitable mock-up of the system, in which the most adverse conditions are simulated, may be used for this purpose. The quantity of fuel in the tank being tested shall not exceed the amount established as the unusable fuel supply for that tank as determined by demonstration of compliance with the provisions of § 3.437 (see also §§ 3.440 and 3.672), plus whatever minimum quantity of fuel it may be necessary to add for the purpose of conducting the flow test. If a fuel flowmeter is provided, the meter shall be blocked during the flow test and the fuel shall flow through the meter bypass.

[§ 3.434 Fuel flow rate for gravity systems . The fuel flow rate for gravity systems (main and reserve supply) shall be 150 percent of the actual take-off fuel consumption of the engine. **]**

§ 3.435 Fuel flow rate for pump systems. The fuel flow rate for pump systems (main and reserve supply) shall be 0.9 pound per hour for each take-off horsepower or 125 percent of the actual take-off fuel consumption of the engine,
whichever is greater. This flow rate shall be applicable to both the primary engine-driven pump and the emergency pumps and shall be available when the pump is running at the speed at which it would normally be operating during
take-off. In the case of hand-operated pumps, this speed shall be considered to be not more than 60 complete cycles (120 single strokes) per minute.

§ 3.436 Fuel flow rate for auxiliary fuel systems and fuel transfer systems. The provisions of § 3.434 or § 3.435, whichever is applicable, shall also apply to auxiliary and transfer systems with the exception that the required fuel flow rate shall be established upon the basis of maximum continuous power and speed instead of take-off power and speed. A lesser flow rate shall be acceptable, however, in the case of a small auxiliary tank feeding into a large main tank, provided a suitable placard is installed to require that the auxiliary tank must only be opened to the main tank when a predetermined satisfactory amount of fuel still remains in the main tank.

§ 3.437 Determination of unusable fuel supply and fuel system operation on low fuel.

(a) The unusable fuel supply for each tank shall be established as not less than the quantity at which the first evidence of malfunctioning occurs under the conditions specified in this section. (See also § 3.440.) In the case of airplanes equipped with more than one fuel tank, any tank which is not required to feed the engine in all of the conditions specified in this section need be investigated only for those flight conditions in which it shall be used and the unusable fuel supply for the particular tank in question shall then be based on the most critical of those conditions which are found to be applicable. In all such cases, information regarding the conditions under which the full amount of usable fuel in the tank can safely be used shall be made available to the operating personnel by means of a suitable placard or instruction in the Airplane Flight Manual.

(b) Upon presentation of the airplane for test, the applicant shall stipulate the quantity of fuel with which he chooses to demonstrate compliance with this provision and shall also indicate which of the following conditions is
most critical from the standpoint of establishing the unusable fuel supply. He shall also indicate the order in which the other conditions are critical from this standpoint:

(1) Level flight at maximum continuous power or the power required for level flight at Vc, whichever is less.

(2) Climb at maximum continuous power at the calculated best angle of climb at minimum weight.

(3) Rapid application of power and subsequent transition to best rate of climb following a power-off glide at 1.3 Vso.

(4) Sideslips and skids in level flight, climb, and glide under the conditions specified in subparagraphs (1), (2), and (3) of this paragraph, of the greatest severity likely to be encountered in normal service or in turbulent air.

(c) In the case of utility category airplanes, there shall be no evidence of malfunctioning during the execution of all approved maneuvers included in the Airplane Flight Manual. During this test the quantity of fuel in each tank shall not exceed the quantity established as the unusable fuel supply, in accordance with paragraph (b) of this section, plus 0.03 gallon for each maximum continuous horsepower for which the airplane is certificated.

(d) In the case of acrobatic category airplanes, there shall be no evidence of malfunctioning during the execution of all approved maneuvers included in the Airplane Flight Manual. During this test the quantity of fuel in each tank shall not exceed that specified in paragraph (c) of this section.

(e) If an engine can be supplied with fuel from more than one tank, it shall be possible to regain the full power and fuel pressure of that engine in not more than 10 seconds (for single engine airplanes) or 20 seconds (for multiengine airplanes) after switching to any full tank after engine malfunctioning becomes apparent due to the depletion of the fuel supply in any tank from which the engine can be fed. Compliance with this provision shall be demonstrated in level flight.

(f) There shall be no evidence of malfunctioning during take-off and climb for 1 minute at the calculated attitude of best angle of climb at take-off power and minimum weight. At the beginning of this test the quantity of fuel in each tank shall not exceed that specified in paragraph (c) of this section.

[§ 3.438 Fuel system hot weather operation . Airplanes with suction lift fuel systems or other fuel system features conducive to vapor formation shall be demonstrated to be free from vapor lock when using fuel at a temperature of 110° F under critical operating conditions. **]**

§ 3.439 Flow between interconnected tanks. In the case of gravity feed systems with tanks who's outlets are interconnected, it shall not be possible for fuel to flow between tanks in quantities sufficient to cause an overflow of fuel from the tank vent when the airplane is operated as specified in § 3.437 (a) and the tanks are full.

FUEL TANKS

§ 3.440 General. Fuel tanks shall be capable of withstanding without failure any vibration, inertia, and fluid and structural loads to which they may be subjected in operation. Flexible fuel tank liners shall be of an acceptable type. Integral type fuel tanks shall be provided with adequate facilities for the inspection and repair of the tank interior. The total usable capacity of the fuel tanks shall not be less than 1 gallon for each seven maximum continuous rated horsepower for which the airplane is certificated. The unusable capacity shall be considered to be the minimum quantity of fuel which will permit compliance with the provisions of § 3.437. The fuel quantity indicator shall be adjusted to account for the unusable fuel supply as specified in § 3.672. If the unusable fuel supply in any tank exceeds 5 percent of the tank capacity or 1 gallon, whichever is greater, a placard and a suitable notation in the Airplane Flight Manual shall be provided to indicate to the flight personnel that the fuel remaining in the tank when the quantity indicator reads zero cannot be used safely in flight. The weight of the unusable fuel supply shall be included in the empty weight of the airplane.

§ 3.441 Fuel tank tests.

(a) Fuel tanks shall be capable of withstanding the following pressure tests without failure or leakage. These pressures may be applied in a manner simulating the actual pressure distribution in service:

(1) Conventional metal tanks and nonmetallic tanks whose walls are not supported by the airplane structure: A pressure of 3.5 psi or the pressure developed during the maximum ultimate acceleration of the airplane with a full tank, whichever is greater.

(2) Integral tanks: The pressure developed during the maximum limit acceleration of the airplane with a full tank, simultaneously with the application of the critical limit structural loads.

(3) Nonmetallic tanks the walls of which are supported by the airplane structure: Tanks constructed of an acceptable basic tank material and type of construction and with actual or simulated support conditions shall be subjected to a pressure of 2 psi for the first tank of a specific design. Subsequent tanks shall be production tested to at least 0.5 psi. The supporting structure shall be designed for the critical loads occurring in the flight or landing strength conditions combined with the fuel pressure loads resulting from the corresponding accelerations.

(b) (1) Tanks with large unsupported or unstiffened flat areas shall be capable of withstanding the following tests without leakage or failure. The complete tank assembly, together with its supports, shall be subjected to a vibration test when mounted in a manner simulating the actual installation. The tank assembly shall be vibrated for 25 hours at a total amplitude of not less than 1/32 of an inch while filled 2/3 full of water. The frequency of vibration shall be 90 percent of the maximum continuous rated speed of the engine unless some other frequency within the normal operating range of speeds of the engine is more critical, in which case the latter speed shall be employed and the time of test shall be adjusted to accomplish the same number of vibration cycles.

(2) In conjunction with the vibration test, the tank assembly shall be rocked through an anxle of 15° on either side of the horizontal (30° total) about an axis parallel to the axis of the fuselage. The assembly shall be rocked at the
rate of 16 to 20 complete cycles per minute.

(c) Integral tanks which incorporate methods of construction and sealing not previously substantiated by satisfactory test data or service experience shall be capable of withstanding the vibration test specified in paragraph (b) of this section.

(d) (1) Tanks with nonmetallic liners shall be subjected to the sloshing portion of the test outlined under paragraph (b) of this section with fuel at room temperature.

(2) In addition, a specimen liner of the same basic construction as that to be used in the airplane shall, when installed in a suitable test tank, satisfactorily withstand the slosh test with fuel at a temperature of 110°F.

§ 3.442 Fuel tank installation.

[(a) The method of supporting tanks shall not be such as to concentrate the loads resulting from the weight of the fuel in the tanks. Pads shall be provided to prevent chafing between the tank and its supports. Materials employed for padding shall be nonabsorbent or shall be treated to prevent the absorption of fuels. If flexible tank liners are employed, they shall be of an approved type, and they shall be so supported that the liner is not required to withstand fluid loads. Interior surfaces of compartments for such liners shall be smooth and free of projections which are apt to cause wear of the liner, unless provisions are made for the protection of the liner at such points or unless the construction of the liner itself provides such protection. A positive pressure shall be maintained within the vapor space of all bladder cells under all conditions of operation including the critical condition of low air speed and rate of descent likely to be encountered in normal operation.**]**

(b) Tank compartments shall be ventilated and drained to prevent the accumulation of inflammable fluids or vapors. Compartments adjacent of tanks which are an integral part of the airplane structure shall also be ventilated and drained.

(c) Fuel tanks shall not be located on the engine side of the fire wall. Not less than one half inch of clear air space shall be provided between the fuel tank and the fire wall. No portion of engine nacelle skin which lies immediately behind a major air egress opening from the engine compartment shall act as the wall of an integral tank. Fuel tanks shall not be located in personnel compartments, except in the case of single-engine airplanes. In such cases
fuel tanks the capacity of which does not exceed 25 gallons may be located in personnel compartments, if adequate ventilation and drainage are provided. In all other cases, fuel tanks shall be isolated from personnel compartments by means of fume and fuel proof enclosures.

§ 3.443 Fuel tank expansion space. Fuel tanks shall be provided with an expansion space of not less than 2 percent of the tank capacity, unless the tank vent discharges clear of the aircraft in which case no expansion space will be required. It shall not be possible inadvertently to fill the fuel tank expansion space when the airplane is in the normal ground attitude.

§ 3.444 Fuel tank sump.

[(a) Each tank shall be provided with a drainable sump having a capacity of not less than 0.25 percent of the tank capacity or 1/16 gallon, whichever is the greater. It shall be acceptable to dispense with the sump if the fuel system is provided with a sediment bowl permitting ground inspection. The sediment bowl shall also be accessible for drainage. The capacity of the sediment chamber shall not be less than 1 ounce per each 20 gallons of the fuel tank capacity.

(b) If a fuel tank sump is provided, the capacity specified in paragraph (a) of this section shall be effective with the airplane in the normal ground attitude and in all normal flight attitudes.]

(c) If a separate sediment bowl is provided, the fuel tank outlet shall be so located that water will drain from all portions of the tank to the outlet when the airplane is in the ground attitude.

§ 3.445 Fuel tank filler connection.

(a) Fuel tank filler connections shall be marked as specified in § 3.767.

(b) Provision shall be made to prevent the entrance of spilled fuel into the fuel tank compartment or any portions of the airplane other than the tank itself. The filler cap shall provide a fuel-tight seal for the main filler opening.
However, small openings in the fuel tank cap for venting purposes or to permit passage of a fuel gauge through the cap shall be permissible.

§ 3.446 Fuel tank vents and carburetor vapor vents.

(a) Fuel tanks shall be vented from the top portion of the expansion space. Vent outlets shall be so located and constructed as to minimize the possibility of their being obstructed by ice or other foreign matter. The vent shall be so constructed as to preclude the possibility of siphoning fuel during normal operation. The vent shall be of sufficient size to permit the rapid relief of excessive differences of pressure between the interior and exterior of the tank. Air spaces of tanks the outlets of which are interconnected shall also be interconnected. There shall be no undrainable points in the vent line where moisture is apt to accumulate with the airplane in either the ground or level flight attitude. Vents shall not terminate at points where the discharge of fuel from the vent outlet will constitute a fire hazard or from which fumes may enter personnel compartments.

(b) Carburetors which are provided with vapor elimination connections shall be provided with a vent line which will lead vapors back to one of the airplane fuel tanks. If more than one fuel tank is provided and it is necessary to use these tanks in a definite sequence for any reason, the vapor vent return line shall lead back to the fuel tank which must be used first unless the relative capacities of the tanks are such that return to another tank is preferable.

§ 3.447-A Fuel tank vents. Provision shall be made to prevent excessive loss of fuel during acrobatic maneuvers including short periods of inverted flight. It shall not be possible for fuel to siphon from the vent when normal flight has been resumed after having executed any acrobatic maneuver for which the airplane is intended.

§ 3.448 Fuel tank outlet. The fuel tank outlet shall be provided with a screen of from 8 to 16 meshes per inch. If a finger strainer is used, the length of the strainer shall not be less than 4 times the outlet diameter. The diameter of the strainer shall not be less than the diameter of the fuel tank outlet. Finger strainers shall be accessible for inspection and cleaning.

FUEL PUMPS

§ 3.449 Fuel pump and pump installation.

(a) If fuel pumps are provided to maintain a supply of fuel to the engine, at least one pump for each engine shall be directly driven by the engine. Fuel pumps shall be adequate to meet the flow requirements of the applicable portions of §§ 3.433-3.436.

[(b) Emergency fuel pumps shall be provided to permit supplying all engines with fuel in case of the failure of any one engine-driven pump, except that if an engine fuel injection pump which has been certificated as an integral part of the engine is used, an emergency pump is not required. Emergency pumps shall be available for immediate use in case of the failure of any other pump. If both the normal pump and emergency pump operate continuously, means shall be provided to indicate to the crew when either pump is malfunctioning.**]**

LINES, FITTINGS, AND ACCESSORIES

§ 3.550 Fuel system lines, fittings, and accessories. Fuel lines shall be installed and supported in a manner which will prevent excessive vibration and will be adequate to withstand loads due to fuel pressure and accelerated flight conditions. Lines which are connected to components of the airplane between which relative motion might exist shall incorporate provisions for flexibility. Flexible hose shall be of an acceptable type.

§ 3.551 Fuel valves.

(a) Means shall be provided to permit the flight personnel to shut off rapidly the flow of fuel to any engine individually in flight. Valves provided for this purpose shall be located on the side of the fire wall most remote from the engine.

(b) Shut-off valves shall be so constructed as to make it possible for the flight personnel to reopen the valves rapidly after they have once been closed.

(c) Valves shall be provided with either positive stops or "feel" in the on and off positions and shall be supported in such a manner that loads resulting from their operation or from accelerated flight conditions are not transmitted to the lines connected to the valve. Valves shall be so installed that the effect of gravity and vibration will tend to turn their handles to the open rather than the closed position.

§ 3.552 Fuel strainer. A fuel strainer shall be provided between the fuel tank outlet and the carburetor inlet. If an engine-driven fuel pump is provided, the strainer shall be located between the tank outlet and the engine-driven pump inlet. The strainer shall be accessible for drainage and cleaning, and the strainer screen shall be removable.

DRAINS AND INSTRUMENTS

[§ 3.553 Fuel system drains. Drains shall be provided to permit safe drainage of the entire fuel system and shall incorporate means for locking in the closed position. The provisions for drainage shall be effective in the normal ground attitude.**]**

§ 3.554 Fuel system instruments. (See § 3.655 and §§ 3.670 through 3.673.)

OIL SYSTEM

[§ 3.561 Oil system. Each engine shall be provided with an independent oil system capable of supplying the engine with an ample quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. The usable oil tank capacity shall not be less than the product of the endurance of the airplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to assure adequate system circulation and cooling. In lieu of a rational analysis of airplane range and oil consumption, a fuel-oil ratio of 30:1 by volume shall be considered acceptable.**]**

§ 3.562 Oil cooling. (See § 3.581 and pertinent sections.)

OIL TANKS

§ 3.563 Oil tanks. Oil tanks shall be capable of withstanding without failure all vibration, inertia, and fluid loads to which they might be subjected in operation. Flexible oil tank liners shall be of an acceptable type.

§ 3.564 Oil tank tests. Oil tank tests shall be the same as fuel tank tests (see § 3.441), except as follows:

(a) The 3.5 psi pressure specified in § 3.441 (a) shall be 5 pound psi.

(b) In the case of tanks with nonmetabllic liners, the test fluid shall be oil rather than fuel as specified in § 3.441 (d) and the slosh test on a specimen liner shall be conducted with oil at a temperature of 250° F.

§ 3.565 Oil tank installation. Oil tank installations shall comply with the requirements of § 3.442 (a) and (b).

§ 3.566 Oil tank expansion space. Oil tanks shall be provided with an expansion space of not less than 10 percent of the tank capacity or ½ gallon, whichever is greater. it shall not be possible inadvertently to fill the oil tank expansion space when the airplane is in the normal ground attitude.

§ 3.567 Oil tank filler connection. Oil tank filler connections shall be marked as specified in § 3.767.

§ 3.568 Oil tank vent.

(a) Oil tanks shall be vented to the engine crankcase from the top of the expansion space in such a manner that the vent connection is not covered by oil under an normal flight conditions. Oil tank vents shall be so arranged that condensed water vapor which might freeze and obstruct the line cannot accumulate at any point.

(b) Category A. Provision shall be made to prevent hazardous loss of oil during acrobatic maneuvers including short periods of inverted flight.

§ 3.569 Oil tank outlet. The oil tank outlet shall not be enclosed or covered by any screen or other guard which might impede the flow of oil. The diameter of the oil tank outlet shall not be less than the diameter of the engine oil pump
inlet. (See also § 3.577.)

LINES, FITTINGS, AND ACCESSORIES

§ 3.570 Oil system lines, fittings, and accessories. Oil lines shall comply with the provisions of § 3.550, except that the inside diameter of the engine oil inlet and outlet lines shall not be less than the diameter of the corresponding engine oil pump inlet and outlet.

§ 3.571 Oil valves. (See § 3.637.)

§ 3.572 Oil radiators. Oil radiators and their support shall be capable of withstanding without failure any vibration, inertia, and oil pressure loads to which they might normally be subjected.

§ 3.573 Oil filters. If the engine is equipped with an oil filter, the filter shall be constructed and installed in such a manner that complete blocking of the flow through the filter element will not jeopardize the continued operation of the
engine oil supply system.

§ 3.574 Oil system drains. Drains shall be provided to permit safe drainage of the entire oil system and shall incorporate means for positive locking in the closed position.

§ 3.575 Engine breather lines.

(a) Engine breather lines shall be so arranged that condensed water vapor which might freeze and obstruct the line cannot accumulate at any point. Breathers shall discharge in a location which will not constitute a fire hazard in case foaming occurs and so that oil emitted from the line will not impinge upon the pilot’s windshield. The breather shall not discharge into the engine air induction system.

(b) Category A. In the case of acrobatic type airplanes, provision shall be made to prevent excessive loss of oil from the breather during acrobatic maneuvers including short periods of inverted flight.

§ 3.576 Oil system instruments. See §§3.655, 3.670, 3.671, and 3.674.

§ 3.577 Propeller feathering system. If the propeller feathering system is dependent upon the use of the engine oil supply, provision shall be made to trap a quantity of oil in the tank in case the supply becomes depleted due to failure of any portion of the lubricating system other than the tank itself. The quantity of oil so trapped shall be sufficient to accomplish the feathering operation and shall be available only to the feathering pump. The ability of the system to accomplish feathering when the supply of oil has fallen to the above level shall be demonstrated.

COOLING

§ 3.581 General. The power-plant cooling provisions shall be capable of maintaining the temperatures of all power-plant components, engine parts, and engine fluids (oil and coolant), at or below the maximum established safe values under critical conditions of ground and flight operation.

TESTS

§ 3.582 Cooling tests. Compliance with the provisions of § 3.581 shall be demonstrated under critical ground, water, and flight operating conditions. If the tests are conducted under conditions which deviate from the highest anticipated summer air temperature (see § 3.583), the recorded power-plant temperatures shall be corrected in accordance with the provisions of §§ 3.584 and 3.585. The corrected temperatures determined in this manner shall not exceed the maximum established safe values. The fuel used during the cooling tests shall be of the minimum octane number approved for the engines involved, and the mixture setting shall be those appropriate to the operating conditions. The test procedures shall be as outlined in §§ 3.586 and 3.587.

§ 3.583 Maximum anticipated summer air temperatures. The maximum anticipated summer air temperature shall be considered to be 100° F, at sea level and to decrease from this value at the rate of 3.6° F, per thousand feet of altitude above sea level.

§ 3.584 Correction factor for cylinder head, oil inlet, carburetor air, and engine coolant inlet temperatures. These temperatures shall be corrected by adding the difference between the maximum anticipated summer air temperature and the temperature of the ambient air at the time of the first occurrence of maximum head, air, oil, or coolant temperature recorded during the cooling test.

§ 3.585 Correction factor for cylinder barrel temperatures. Cylinder barrel temperatures shall be corrected by adding 0.7 of the difference between the maximum anticipated summer air temperature and the temperature of the ambient air at the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

§ 3.586 Cooling test procedure for single engine airplanes. This test shall be conducted by stabilizing engine temperatures in flight and then starting at the lowest practicable altitude and climbing for 1 minute at take-off power. At the end of 1 minute, the climb shall be continued at maximum continuous power until at least 5 minutes after the occurrence of the highest temperature recorded. The climb shall not be conducted at a speed greater than the best rate-of-climb speed with maximum continuous power unless:

(a) The slope of the flight path at the speed chosen for the cooling test is equal to or greater than the minimum required angle of climb (see § 3.85 (a)), and

(b) A cylinder head temperature indicator is provided as specified in § 3.675.

§ 3.587 Cooling test procedure for multiengine airplanes—

(a) Airplanes which meet the minimum one-engine-inoperative climb performance specified in § 3.85 (b). The engine cooling test for these airplanes shall be conducted with the airplane in the configuration specified in § 3.85 (b), except that the operating engine(s) shall be operated at maximum continuous power or at full throttle when above the critical altitude. After stabilizing temperatures in flight, the climb shall be started at the lower of the two following altitudes and shall be continued until at least 5 minutes after the highest temperature has been recorded:

(1) 1,000 feet below the engine critical altitude or at the lowest practicable altitude (when applicable).

(2) 1,000 feet below the altitude at which the single-engine-inoperative rate of climb is 0.02 Vso2. The climb shall be conducted at a speed not in excess of the highest speed at which compliance with the climb requirement of § 3.85 (b) can be shown. However, if the speed used exceeds the speed for best rate of climb with one engine inoperative, a cylinder head temperature indicator shall be provided as specified in § 3.675.

(b) Airplanes which cannot meet the minimum one-engine-inoperative climb performance specified in § 3.85 (b). The engine cooling test for these airplanes shall be the same as in paragraph (a) of this section, except that after stabilizing temperatures in flight, the climb (or descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb) shall be commenced at as near sea level as practicable and shall be conducted at the best rate-of-climb speed (or the speed of minimum rate of descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb).

LIQUID COOLING SYSTEMS

§ 3.588 Independent systems. Each liquid cooled engine shall be provided with an independent cooling system. The cooling system shall be so arranged that no air or vapor can be trapped in any portion of the system, except the expansion tank, either during filling or during operation.

§ 3.589 Coolant tank. A coolant tank shall be provided. The tank capacity shall not be less than 1 gallon plus 10 percent of the cooling system capacity. Coolant tanks shall be capable of withstanding without failure all vibration,
inertia, and fluid loads to which they may be subjected in operation. Coolant tanks shall be provided with an expansion space of not less than 10 percent of the total cooling system capacity. It shall not be possible inadvertently to fill the expansion space with the airplane in the normal ground attitude.

§ 3.590 Coolant tank tests. Coolant tank tests shall be the same as fuel tank tests (see § 3.441), except as follows:

(a) The 3.5 pounds per square inch pressure test of § 3.441 (a) shall be replaced by the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 3.5 pounds per square inch, whichever is greater, plus the maximum working pressure of the system.

(b) In the case of tanks with nonmetallic liners, the test fluid shall be coolant rather than fuel as specified in § 3.441 (d), and the slosh test on a specimen liner shall be conducted with coolant at operating temperature.

§ 3.591 Coolant tank installation. Coolant tanks shall be supported in a manner so as to distribute the tank loads over a large portion of the tank surface. Pads shall be provided to prevent chafing between the tank and the support. Material used for padding shall be nonabsorbent or shall be treated to prevent the absorption of inflammable fluids.

§ 3.592 Coolant tank filler connection. Coolant tank filler connections shall be marked as specified in § 3.767. Provisions shall be made to prevent the entrance of spilled coolant into the coolant tank compartment or any portions of the airplane other than the tank itself. Recessed coolant filler connections shall be drained and the drain shall discharge clear of all portions of the airplane.

§ 3.593 Coolant lines, fittings, and accessories. Coolant lines shall comply with the provisions of § 3.550, except that the inside diameter of the engine coolant inlet and outlet lines shall not be less than the diameter of the corresponding engine inlet and outlet connections.

§ 3.594 Coolant radiators. Coolant radiators shall be capable of withstanding without failure any vibration, inertia, and coolant pressure loads to which they may normally be subjected. Radiators shall be supported in a manner which will permit expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator. If the coolant employed is inflammable, the air intake duct to the coolant radiator shall be so located that flames issuing from the nacelle in case of fire cannot impinge upon the radiator.

§ 3.595 Cooling system drains. One or more drains shall be provided to permit drainage of the entire cooling system, including the coolant tank, radiator, and the engine, when the airplane is in the normal ground attitude. Drains shall discharge clear of all portions of the airplane and shall be provided with means for positively locking the drain in the closed position. Cooling system drains shall be accessible.

§ 3.596 Cooling system instruments. See §§ 3.655, 3.670, and 3.671.

INDUCTION SYSTEM

§ 3.605 General.

(a) The engine air induction system shall permit supplying an adequate quantity of air to the engine under all conditions of operation.

[(b) Each engine shall be provided with at least two separate air intake sources, except that in the case of an engine equipped with a fuel injector only one air intake source need be provided, if the air intake, opening, or passage is unobstructed by a screen, filter, or other part on which ice might form and so restrict the air flow as to affect adversely engine operation. It shall be permissible for primary air intakes to open within the cowling only if that portion of the cowling is isolated from the engine accessory section by means of a fire-resistant diaphragm or if provision is made to prevent the emergence of backfire flames. Alternate air intakes shall be located in a sheltered position and shall not open within the cowling unless they are so located that the emergence of backfire flames will not result in a hazard. Supplying air to the engine through the alternate air intake system of the carburetor air preheater shall not result in the loss of excessive power in addition to the power lost due to the rise in the temperature of the air.**]**

§ 3.606 Induction system de-icing and antiicing provisions. The engine air induction system shall incorporate means for the prevention and elimination of ice accumulations in accordance with the provisions in this section. It shall be demonstrated that compliance with the provisions outlined in the following paragraphs can be accomplished when the airplane is operating in air at a temperature of 30° F, when the air is free of visible moisture.

(a) Airplanes equipped with sea level engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 90° F. when the engine is operating at 75 percent of its maximum continuous power.

(b) Airplanes equipped with altitude engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 120° F. when the engine is operating at 75 percent of its maximum continuous power.

(c) Airplanes equipped with altitude engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a preheater capable of providing a heat rise of 100° F. when the engine is operating at 60 percent of its maximum continuous power. However, the preheater need not provide a heat rise in excess of 40°F. if a fluid de-icing system complying with the provisions of §§ 3.607-3.609 is also installed.

[(d) Airplanes equipped with sea level engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a sheltered source of air warmed at least to the extent to which the cylinder cooling air is warmed. **]**

§ 3.607 Carburetor de-icing fluid flow rate. The system shall be capable of providing each engine with a rate of fluid flow, expressed in pounds per hour, of not less than 2.5 multiplied by the square root of the maximum continuous power of the engine. This flow shall be available to all engines simultaneously. The fluid shall be introduced into the air induction system at a point close to, and upstream from, the carburetor. The fluid shall be introduced in a manner to assure its equal distribution over the entire cross section of the induction system air passages.

§ 3.608 Carburetor fluid de-icing system capacity. The fluid de-icing system capacity shall not be less than that required to provide fluid at the rate specified in § 3.607 for a time equal to 3 percent of the maximum endurance of the airplane. However, the capacity need not in any case exceed that required for 2 hours of operation nor shall it be less than that required for 20 minutes of operation at the above flow rate. If the available preheat exceeds 50° F. but is less than 100° F., it shall be permissible to decrease the capacity of the system in proportion to the heat rise available in excess of 50° F.

§ 3.609 Carburetor fluid de-icing system detail design. Carburetor fluid de-icing systems shall comply with provisions for the design of fuel systems, except as specified in §§ 3.607 and 3.608, unless such provisions are manifestly in applicable.

§ 3.610 Carburetor air preheater design. Means shall be provided to assure adequate ventilation of the carburetor air preheater when the engine is being operated in cold air. The preheater shall be constructed in such a manner as to permit inspection of exhaust manifold parts which it surrounds and also to permit inspection of critical portions of the preheater itself.

§ 3.611 Induction system ducts. Induction system ducts shall be provided with drains which will prevent the accumulation of fuel or moisture in all normal ground and flight attitudes. No open drains shall be located on the pressure side of turbo-supercharger installations. Drains shall not discharge in a location which will constitute a fire hazard. Ducts which are connected to components of the airplane between which relative motion may exist shall incorporate provisions for flexibility.

§ 3.612 Induction system screens. If induction system screens are employed, they shall be located upstream from the carburetor. It shall not be possible for fuel to impinge upon the screen. Screens shall not be located in portions of the induction system which constitute the only passage through which air can reach the engine, unless the available preheat is 100° F, or over and the screen is so located that it can be de-iced by the application of heated air. De-icing of screens by means of alcohol in lieu of heated air shall not be acceptable.

EXHAUST SYSTEM

§ 3.615 General.

(a) The exhaust system shall be constructed and arranged in such a manner as to assure the safe disposal of exhaust gases without the existence of a hazard of fire or carbon monoxide contamination of air in personnel compartments.

(b) Unless suitable precautions are taken, exhaust system parts shall not be located in close proximity to portions of any systems carrying inflammable fluids or vapors nor shall they be located under portions of such systems which may be subject to leakage. All exhaust system components shall be separated from adjacent inflammable portions of the airplane which are outside the engine compartment by means of fireproof shields. Exhaust gases shall not be discharged at a location which will cause a glare seriously affecting pilot visibility at night, nor shall they discharge within dangerous proximity of any fuel or oil system drains. All exhaust system components shall be ventilated to prevent the existence of points of excessively high temperature.

§ 3.616 Exhaust manifold. Exhaust manifolds shall be made of fireproof, corrosion resistant materials, and shall incorporate provisions to prevent failure due to their expansion when heated to operating temperatures.

Exhaust manifolds shall be supported in a manner adequate to withstand all vibration and inertia loads to which they might be
subjected in operation. Portions of the manifold which are connected to components between which relative motion might exist shall incorporate provisions for flexibility.

§ 3.617 Exhaust heat exchangers.

(a) Exhaust heat exchanges shall be constructed and installed in such a manner as to assure their ability to withstand without failure all vibration, inertia, and other loads to which they might normally be subjected. Heat exchangers shall be constructed of materials which are suitable for continued operation at high temperatures and
which are adequately resistant to corrosion due to products contained in exhaust gases.

(b) Provisions shall be made for the inspection of all critical portions of exhaust heat exchangers, particularly if a welded construction is employed. Heat exchangers shall be ventilated under all conditions in which they are subject to contact with exhaust gases.

§ 3.618 Exhaust heat exchangers used in ventilating air heating systems. Heat exchangers of this type shall be so constructed as to preclude the possibility of exhaust gases entering the ventilating air.

FIRE WALL AND COWLING

§ 3.623 Fire walls. All engines, auxiliary power units, fuel burning heaters, and other combustion equipment which are intended for operation in flight shall be isolated from the remainder of the airplane by means of fire walls, or shrouds, or other equivalent means.

§ 3.624 Fire wall construction.

(a) Fire walls and shrouds shall be constructed in such a manner that no hazardous quantity of air, fluids, or flame can pass from the engine compartment to other portions of the airplane. All openings in the fire wall or shroud shall be sealed with closefitting fireproof grommets, bushings, or fire-wall fittings. **[**However, fire-resistant material may be used in such applications on single-engine airplanes using unsupercharged wet sump engines, provided that the opening which may result in case of fire will not involve a serious hazard from the standpoint of flame propagation to the sheltered side of the fire wall.**]**

(b) Fire walls and shrouds shall be constructed of fireproof material and shall be protected against corrosion. The following materials have been found to comply with this requirement:

(1) Heat- and corrosion-resistant steel 0.015 inch thick,

(2) Low carbon steel, suitably protected against corrosion, 0.018 inch thick.

§ 3.625 Cowling.

(a) Cowling shall be constructed and supported in such a manner as to be capable of resisting all vibration, inertia, and air loads to which it may normally be subjected. Provision shall be made to permit rapid and complete drainage of all portions of the cowling in all normal ground and flight attitudes. Drains shall not discharge in locations constituting a fire hazard.

(b) Cowling shall be constructed of fire resistant material. All portions of the airplane lying behind openings in the engine compartment cowling shall also be constructed of fire-resistant materials for a distance of at least 24 inches aft of such openings. Portions of cowling which are subjected to high temperatures due to proximity to exhaust system ports or exhaust gas impingement shall be constructed of fireproof material.

POWER-PLANT CONTROLS AND ACCESSORIES
CONTROLS

§ 3.627 Power-plant controls. Power-plant controls shall comply with the provisions of §§ 3.384 and 3.759. Controls shall maintain any necessary position without constant attention by the flight personnel and shall not tend to creep due to control loads or vibration. Flexible controls shall be of an acceptable type. Controls shall have adequate strength and rigidity to withstand operating loads without failure or excessive deflection.

§ 3.628 Throttle controls. A throttle control shall be provided to give independent control for each engine. Throttle controls shall afford a positive and immediately responsive means of controlling the engine(s). Throttle controls shall be grouped and arranged in such a manner as to permit separate control of each engine and also simultaneous control of all engines.

§ 3.629 Ignition switches. Ignition switches shall provide control for each ignition circuit on each engine. It shall be possible to shut off quickly all ignition on multiengine airplanes, either by grouping of the individual switches or by providing a master ignition control.

§ 3.630 Mixture controls. If mixture controls are provided, a separate control shall be provided for each engine. The controls shall be grouped and arranged in such a manner as to permit both separate and simultaneous control of
all engines.

§ 3.631 Propeller speed and pitch controls. (See also § 3.421 (a).) If propeller speed or pitch controls are provided, the controls shall be grouped and arranged in such a manner as to permit control of all propellers, both separately and together. The controls shall permit ready synchronization of all propellers on multiengine airplanes.

§ 3.632 Propeller feathering controls. If propeller feathering controls are provided, a separate control shall be provided for each propeller. Propeller feathering controls shall be provided with means to prevent inadvertent operation.

§ 3.633 Fuel system controls. Fuel system controls shall comply with requirements of § 3.551 (c).

§ 3.634 Carburetor air preheat controls. Separate control shall be provided to regulate the temperature of the carburetor air for each engine.

ACCESSORIES

§ 3.635 Power-plant accessories. Engine driven accessories shall be of a type satisfactory for installation on the engine involved and shall utilize the provisions made on the engine for the mounting of such units. Items of electrical equipment subject to arcing or sparking shall be installed so as to minimize the possibility of their contact with any inflammable fluids or vapors which might be present in a free state.

§ 3.636 Engine battery ignition systems.

(a) Battery ignition systems shall be supplemented with a generator which is automatically made available as an alternate source of electrical energy to permit continued engine operation in the event of the depletion of any battery.

(b) The capacity of batteries and generators shall be sufficient to meet the simultaneous demands of the engine ignition system and the greatest demands of any of the airplane's electrical system components which may draw
electrical energy from the same source. Consideration shall be given to the condition of an inoperative generator, and to the condition of a completely depleted battery when the generator is running at its normal operating speed. If only
one battery is provided, consideration shall also be given to the condition in which the battery is completely depleted and the generator is operating at idling speed.

(c) Means shall be provided to warn the appropriate flight personnel if malfunctioning of any part of the electrical system is causing the continuous discharging of a battery used for engine ignition. (See § 3.629 for ignition
switches.)

POWER-PLANT FIRE PROTECTION

[§ 3.637 Powerplant fire protection. Suitable means shall be provided to shut off the flow in all lines carrying flammable fluids into the engine compartment of multiengine airplanes required to comply with the provisions of § 3.85 (b).**]**

SUBPART F - EQUIPMENT

§ 3.651 General. The equipment specified in § 3.655 shall be the minimum installed when the airplane is submitted to determine its compliance with the airworthiness requirements. Such additional equipment as is necessary for a specific type of operation is specified in other pertinent parts of the Civil Air Regulations, but, where necessary, its installation and that of the items mentioned in § 3.655 is covered herein.

§ 3.652 Functional and installational requirements. Each item of equipment which is essential to the safe operation of the airplane shall be found by the Administrator to perform adequately the functions for which it is to be used, shall function properly when installed, and shall be adequately labeled as to its identification, function, operational limitations, or any combination of these, whichever is applicable. Items of equipment for which type certification is required shall have been certificated in accordance with the provisions of Part 15 of this chapter (or previous regulations) and such other parts as may be applicable.

BASIC EQUIPMENT

§ 3.655 Required basic equipment. The following table shows the basic equipment items required for type and airworthiness certification of an airplane:

(a) Flight and navigational instruments.

(1) Air-speed indicator (see § 3.663).

(2) Altimeter.

(3) Magnetic direction indicator (see § 3.666)

(b) Power-plant instruments—(1) For each engine or tank. (i) Fuel quantity indicator (see § 3.672).

(ii) Oil pressure indicator.

(iii) Oil temperature indicator.

(iv) Tachometer.

(2) For each engine or tank (if required in reference section). (i) Carburetor air temperature indicator (see § 3.676).

(ii) Coolant temperature indicator (if liquid cooled engines used).

(iii) Cylinder head temperature indicator (see § 3.675).

(iv) Fuel pressure indicator (if pump-fed engines used).

(v) Manifold pressure indicator (if altitude engines used).

(vi) Oil quantity indicator (see § 3.674).

(c) Electrical equipment (if required by reference section).

(1) Master switch arrangement (see § 3.688).

(2) Adequate source(s) of electrical energy (see §§ 3.682 and 3.685).

(3) Electrical protective devices (see § 3.690).

(d) Miscellaneous equipment.

(1) Approved safety belts for all occupants (see Sec. 3.715).

(2) Airplane Flight Manual (see § 3.777).

INSTRUMENTS; INSTALLATION
GENERAL

§ 3.661 Arrangement and visibility of instrument installations.

(a) Flight, navigation, and power-plant instruments for use by each pilot shall be easily visible to him.

(b) On multiengine airplanes, identical power-plant instruments for the several engines shall be so located as to, prevent any confusion as to the engines to which they relate.

§ 3.662 Instrument panel vibration characteristics. Vibration characteristics of the instrument panel shall not be such as to impair the accuracy of the instruments or to cause damage to them.

FLIGHT AND NAVIGATIONAL INSTRUMENTS

§ 3.663 Air-speed indicating system. This system shall be so installed that the air-speed indicator shall indicate true air speed at sea level under standard conditions to within an allowable installational error of not more than plus or minus 3 percent of the calibrated air speed or 5 miles per hour, whichever is greater, throughout the operating range of the airplane with flaps up from Vc to 1.3 Vs1 and with flaps at 1.3 Vs1. The calibration shall be made in flight.

§ 3.664 Air-speed indicator-marking. The air-speed indicator shall be marked as specified in § 3.757.

§ 3.665 Static air vent system. All instruments provided with static air case connections shall be so vented that the influence of airplane speed, the opening and closing of windows, air-flow variation, moisture, or other foreign matter will not seriously affect their accuracy.

§ 3.666 Magnetic direction indicator. The magnetic direction indicator shall be so installed that its accuracy shall not be excessively affected by the airplane's vibration or magnetic fields. After the direction indicator has been compensated, the installation shall be such that the deviation in level flight does not exceed 10 degrees on any heading. A suitable calibration placard shall be provided as specified in § 3.758.

§ 3.667 Automatic pilot system. If an automatic pilot system is installed:

(a) The actuating (servo) devices shall be of such design that they can, when necessary, be positively disengaged from operating the control system or be overpowered by the human pilot to enable him to maintain satisfactory control of the airplane.

(b) A satisfactory means shall be provided to indicate readily to the pilot the alignment of the actuating device in relation to the control system which it operates, except when automatic synchronization is provided.

(c) The manually operated control(s) for the system's operation shall be readily accessible to the pilot.

(d) The automatic pilot system shall be of such design and so adjusted that it cannot produce loads in the control system and surfaces greater than those for which they were designed.

§ 3.668 Gyroscopic indicators (air-driven type). All air-driven gyroscopic instruments installed in airplanes which are certificated for instrument flight operations shall derive their energy from a reliable suction source of sufficient capacity to maintain their required accuracy at all speeds above the best rate-of-climb speed. In addition the system shall be so installed as to preclude malfunctioning due to rain, oil, or other detrimental elements. On multiengine airplanes, the following detail requirements shall be applicable:

(a) Two sources actuated by separate means shall be provided, either one of which shall be of sufficient capacity to operate all of the air-driven gyroscopic instruments with which the airplane is equipped, with the airplane in normal cruising attitude at 65 percent maximum continuous power.

(b) A suitable means shall be provided in the attendant installation where the source lines connect into a common line to select either suction air source for the proper functioning of the instruments should failure of one source or a breakage of one source line occur. When an automatic means to permit simultaneous air flow is provided in the system, a suitable method for maintaining suction shall be provided. In order to indicate which source of energy has failed, a visual means shall be provided to indicate this condition to the flight crew.

§ 3.669 Suction gauge. A suction gauge shall be provided and so installed as to indicate readily to the flight crew while in flight the suction in inches of mercury which is being applied to the air-driven types of gyroscopic instruments. This gauge shall be connected to the instruments by a suitable system.

POWER-PLANT INSTRUMENTS

§ 3.670 Operational markings. Instruments shall be marked as specified in § 3.759.

§ 3.671 Instrument lines. Power-plant instrument lines shall comply with the provisions of § 3.550. In addition, instrument lines carrying inflammable fluids or gases under pressure shall be provided with restricted orifices or other safety devices at the source of the pressure to prevent escape of excessive fluid or gas in case of line failure.

[§ 3.672 Fuel quantity indicator . Means shall be provided to indicate to the flight personnel the quantity of fuel in each tank during flight. Tanks, the outlet and air spaces of which are interconnected, may be considered as one tank and need not be provided with separate indicators. Exposed sight gauges shall be so installed and guarded as to preclude the possibility of breakage or damage. Sight gauges which form a trap in which water can collect and freeze shall be provided with means to permit drainage on the ground. Fuel quantity gauges shall be calibrated to read zero during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply as defined by § 3.437. Fuel gauges need not be provided for small auxiliary tanks which are used only to transfer fuel to other tanks, provided that the relative size of the tanks, the rate of fuel transfer, and the instructions pertaining to the use of the tanks are adequate to guard against overflow and to assume that the crew will receive prompt warning in case transfer is not being achieved as intended.**]**

§ 3.673 Fuel flowmeter system. When a fuel flowmeter system is installed in the fuel line(s), the metering component shall be of such design as to include a suitable means for bypassing the fuel supply in the event that malfunctioning of the metering component offers a severe restriction to fuel flow.

§ 3.674 Oil quantity indicator. Ground means, such as a slick gauge, shall be provided to indicate the quantity of oil in each tank. If an oil transfer system or a reserve oil supply system is installed, means shall be provided to indicate to the flight personnel during flight the quantity of oil in each tank.

§ 3.675 Cylinder head temperature indicating system for air-cooled engines. A cylinder head temperature indicator shall be provided for each engine on airplanes equipped with cowl flaps. In the case of airplanes which do not have cowl flaps, an indicator shall be provided if compliance with the provisions of § 3.581 is demonstrated at a speed in excess of the speed of best rate of climb.

§ 3.676 Carburetor air temperature indicating system. A carburetor air temperature indicating system shall be provided for each altitude engine equipped with a preheater which is capable of providing a heat rise in excess of 60°F.

ELECTRICAL SYSTEMS AND EQUIPMENT

§ 3.681 Installation.

(a) Electrical systems in airplanes shall be free from hazards in themselves, in their method of operation, and in
their effects on other parts of the airplane. Electrical equipment shall be of a type and design adequate for the use intended. Electrical systems shall be installed in such a manner that they are suitably protected from fuel, oil, water, other detrimental substances, and mechanical damage.

(b) Items of electrical equipment required for a specific type of operation are listed in other pertinent parts of the Civil Air Regulations.

BATTERIES

§ 3.682 Batteries. When an item of electrical equipment which is essential to the safe operation of the airplane is installed, the battery required shall have sufficient capacity to supply the electrical power necessary for dependable operation of the connected electrical equipment.

§ 3.683 Protection against acid. If batteries are of such a type that corrosive substance may escape during servicing or flight, means such as a completely enclosed compartment shall be provided to prevent such substances from coming in contact with other parts of the airplane which are essential to safe operation. Batteries shall be accessible for servicing and inspection on the ground.

§ 3.684 Battery vents. The battery container or compartment shall be vented in such manner that gases released by the battery are carried outside the airplane.

GENERATORS

§ 3.685 Generator. Generators shall be capable of delivering their continuous rated power.

§ 3.686 Generator controls. Generator voltage control equipment shall be capable of dependably regulating the generator output within rated limits.

§ 3.687 Reverse current cut-out. A generator reverse current cut-out shall disconnect the generator from the battery and other generators when the generator is developing a voltage of such value that current sufficient to cause malfunctioning can flow into the generator.

MASTER SWITCH

§ 3.688 Arrangement. If electrical equipment is installed, a master switch arrangement shall be provided which will
disconnect all sources of electrical power from the main distribution system at a point adjacent to the power sources.

§ 3.689 Master switch installation. The master switch or its controls shall be so installed that it is easily discernible and accessible to a member of the crew in flight.

PROTECTIVE DEVICES

§ 3.690 Fuses or circuit breakers. If electrical equipment is installed, protective devices (fuses or circuit breakers) shall be installed in the circuits to all electrical equipment, except that such items need not be installed in the main circuits of starter motors or in other circuits where no hazard is presented by their omission.

§ 3.691 Protective devices installation. Protective devices in circuits essential to safety in flight shall be so located and identified that fuses may be replaced or circuit breakers reset readily in flight.

§ 3.692 Square fuses. If fuses are used, one spare of each rating or 50 percent spare fuses of each rating, whichever is greater, shall be provided.

ELECTRIC CABLES

§ 3.693 Electric cables. If electrical equipment is installed, the connecting cables used shall be in accordance with recognized standards for electric cable of a slow burning type and of suitable capacity.

SWITCHES

§ 3.694 Switches. Switches shall be capable of carrying their rated current and shall be of such construction that there is sufficient distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting.

§ 3.695 Switch installation. Switches shall be so installed as to be readily accessible to the appropriate crew member and shall be suitably labeled as to operation and the circuit controlled.

INSTRUMENT LIGHTS

§ 3.696 Instrument lights. If instrument lights are required, they shall be of such construction that there is sufficient distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting. They shall provide sufficient illumination to make all instruments and controls easily readable and discernible, respectively.

§ 3.697 Instrument light installation. Instrument lights shall be installed in such a manner that their direct rays are shielded from the pilot's eyes. Direct rays shall not be reflected from the windshield or other surfaces into the pilot's eyes.

LANDING LIGHTS

§ 3.698 Landing lights. If landing lights are installed, they shall be of an acceptable type.

§ 3.699 Landing light installation. Landing lights shall be so installed that there is no dangerous glare visible to the pilot and also so that the pilot is not seriously affected by halation. They shall be installed at such a location that they provide adequate illumination for night landing.

POSITION LIGHTS

§ 3.700 Position light system installation.

(a) General. The provisions of §§ 3.700 through 3.703 shall be applicable to the position light system as a whole, and shall be complied with if a single circuit type system is installed. 1 The single circuit system shall include the items specified in paragraphs (b) through (f) of this section.

(b) Forward position lights . Forward position lights shall consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the airplane in such a location that, with the airplane in normal flying position, the red light is displayed on the left side and the green light is displayed on the right side. The individual lights shall be type certificated in accordance with the applicable provisions of Part 15 of the Civil Air Regulations.

(c) Rear position light . The rear position light shall be a white light mounted as far aft as practicable. The light shall be type certificated in accordance with the applicable provisions of Part 15 of the Civil Air Regulations.

(d) Circuit. The two forward position lights and the rear position light shall constitute a single circuit.

(e) Flasher. If employed, an approved position light flasher for a single circuit system shall be installed. The flasher shall be such that the system is energized automatically at a rate of not less than 60 nor more than 100 flashes per minute with an on-off ratio between 2:1 and 1:1. Unless the flasher is of a fail-safe type, means shall be provided in the system to indicate to the pilot when there is a failure of the flasher and a further means shall be provided for turning the lights on steady in the event of such failure.

(f) Light covers and color filters . Light covers or color filters used shall be of noncumbustible material and shall be constructed so that they will not change color or shape or suffer any appreciable loss of light transmission during normal use.

3.701 Position light system dihedral angles . The forward and rear position lights as installed on the airplane shall show unbroken light within dihedral angles specified in paragraphs (a) through (c) of this section.

(a) Dihedral angle L (left) shall be considered formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane and the either at 110° to the left of the first, when looking forward along the longitudinal axis.

(b) Dihedral angle R (right) shall be considered formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane and the other at 110° to the right of the first, when looking forward along the longitudinal axis.

(c) Dihedral angle A (aft) shall be considered formed by two intersecting vertical planes making angles of 70° to the right and 70° to the left, respectively, looking aft along the longitudinal axis, to a vertical plane passing through the longitudinal axis.

3.702 Position light distribution and intensities .

(a) General. The intensities prescribed in this section are those to be provided by new equipment with all light covers and color filters in place. Intensities shall be determined with the light source operating at a steady value equal to the average luminous output of the light source at the normal operating voltage of the airplane. The light distribution and intensities of position lights shall comply with the provisions of paragraph (b) and (c) of this section.

(b) Forward position lights . Within dihedral angle L for the left light and within dihedral angle R for the right light each forward position light shall have intensities, in any plane through the longitudinal axis of the unit, of not less than 8 candles for the first 30° as measured from the longitudinal axis, of not less than 4 candles for the next 30°, and of not less than 3 candles for the remaining directions. The intensity of an overlapping beam of the right forward position light shall be reduced to two candles or less in all directions within the first 10° of dihedral angle L. Within the next 10° of dihedral angle L the overlapping intensity in all directions shall be reduced to 0.5 candle or less. Similar limits shall apply to an overlapping beam of the left forward position light in dihedral angle R. The intensities of overlapping beams of the forward position light shall be reduced to 0.5 candle or less in all directions within the first 10° of dihedral angle A. Outside of the aforementioned overlap limits the stray light intensity from the forward position lights shall not exceed 0.5 candle in all directions within dihedral angles L, R, and A.

(c) Rear position light . The rear position light shall have an intensity of not less than 4 candles in any direction within dihedral angle A. Within a 140° cone, the axis of which is coincident with the longitudinal axis of the airplane, in dihedral angle A, the intensity shall not be less than 8 candles. The intensity of an overlapping beam of the rear position light shall be reduced to 1 candle or less in all directions within the first 20° of dihedral angles L and R. Outside of these overlap limits the stray light intensity from the rear position light shall not exceed 1 candle in all directions within dihedral angles L and R.

3.703 Color specifications . The colors of the position lights shall have the International Commission on Illumination chromatically coordinates as set forth in paragraph (a) through (c) of this section.

(a) Aviation red.
y is not greater than 0.335,
z is not greater than 0.002;

(b) Aviation green .
x is not greater than 0.440 - 0.320y,
x is not greater than y - 0.170,
y is not less than 0.390 - 0.170x;

(c) Aviation white.
x is not less than 0.350,
x is not greater than 0.540,
y - yo is not numerically greater than 0.01, y o being the y coordinate of the Planckian radiator for which x o = x.**]**

[RIDING LIGHT]

[§ 3.704 Riding light.

(a) When a riding (anchor) light is required for a seaplane, flying boat, or amphibian, it shall be capable of showing a white light for at least 2 miles at night under clear atmospheric conditions.

(b) The riding light shall be installed to show the maximum unbroken light practicable when the airplane is moored or drifting on the water. Externally hung lights shall be acceptable.**]**

§ 3.705 **[**Rescinded.**]**

SAFETY EQUIPMENT; INSTALLATION

§ 3.711 Marking. Required safety equipment which the crew is expected to operate at a time of emergency, such as flares and automatic life raft releases, shall be readily accessible and plainly marked as to its method of operation. When such equipment is carried in lockers, compartments, or other storage places, such storage places shall be marked for the benefit of passengers and crew.

§ 3.712 De-icers. When pneumatic deicers are installed, the installation shall be in accordance with approved data. Positive means shall be provided for the deflation of the pneumatic boots.

§ 3.713 Flare requirements. When parachute flares are required, they shall be of a type certificated in accordance with Part 15 of this chapter.

§ 3.714 Flare installation. Parachute flares shall be releasable from the pilot compartment and so installed that danger of accidental discharge is reduced to a minimum. The installation shall be demonstrated in flight to eject flares satisfactorily, except in those cases where inspection indicates a ground test will be adequate. If the flares are ejected so that recoil loads are involved, structural provisions for such loads shall be made.

§ 3.715 *Safety belts.* Airplanes manufactured on or after January 1, 1951, shall be equipped with safety belts approved in accordance with § 3.31. In no case shall the rated strength of the safety belt be less than that corresponding with the ultimate load factors specified in § 3.386(a), taking due account of the dimensional characteristics of the safety belt installation for the specific seat or berth arrangement. Safety belts shall be attached so that no part of the anchorage will fail at a load lower than that corresponding with the ultimate load factors specified in § 3.386.

EMERGENCY FLOTATION AND SIGNALING EQUIPMENT

§ 3.716 Rafts and life preservers. An approved life raft or approved life preserver, when required by other parts of the Civil Air Regulations, is one approved by either the Administrator, the Bureau of Marine Inspection and Navigation, the United States Army Air Forces, or the Bureau of Aeronautics, Navy Department.

§ 3.717 Installation. When such emergency equipment is required, it shall be so installed as to be readily available to the crew and passengers. Rafts released automatically or by the pilot shall be attached to the airplane by
means of a line to keep them adjacent to the airplane. The strength of the line shall be such that it will break before submerging the empty raft.

§ 3.718 Signaling device. Signaling devices, when required by other parts of the Civil Air Regulations, shall be accessible, function satisfactorily, and be free from any hazard in their operation.

RADIO EQUIPMENT; INSTALLATION

§ 3.721 General. Radio equipment and installations in the airplane shall be free from hazards in themselves, in their method of operation, and in their effects on their components of the airplane.

MISCELLANEOUS EQUIPMENT; INSTALLATION

§ 3.725 Accessories for multiengine airplanes. Engine driven accessories essential to the safe operation of the airplane shall be so distributed among two or more engines that the failure of any one engine will not impair the safe operation of the airplane by the malfunctioning of these accessories.

HYDRAULIC SYSTEMS

§ 3.726 General. Hydraulic systems and elements shall be so designed as to withstand, without exceeding the yield point, any structural loads which might be imposed in addition to the hydraulic loads.

§ 3.727 Tests. Hydraulic systems shall be substantiated by proof pressure tests. When proof tested, no part of the hydraulic system shall fail, malfunction, or experience a permanent set. The proof load of any system shall be 15
times the maximum operating pressure of that system.

§ 3.728 Accumulators. Hydraulic accumulators or pressurized reservoirs shall not be installed on the engine side of the fire wall, except when they form an integral part of the engine or propeller.

SUBPART G—OPERATING LIMITATIONS AND INFORMATION

§ 3.735 General. Means shall be provided to inform adequately the pilot and other appropriate crew members of all operating limitations upon which the type design is based. Any other information concerning the airplane found by the Administrator to be necessary for safety during its operation shall also be made available to the crew. (See §§ 3.755 and 3.777.)

LIMITATIONS

§ 3.737 Limitations. The operating limitations specified in §§ 3.738-3.750 and any similar limitations shall be established for any airplane and made available to the operator as further described in §§ 3.755-3.780, unless its design is such that they are unnecessary for safe operation.

AIR SPEED

§ 3.738 Air speed. Air-speed limitations shall be established as set forth in §§ 3.739-3.743.

§ 3.739 Never-exceed speed (Vne). This speed shall not exceed the lesser of the following:

(a) 0.9 Vd chosen in accordance with § 3.184.

(b) 0.9 times the maximum speed demonstrated in accordance with § 3.159, but shall not be less than 0.9 times the minimum value of Vd permitted by § 3.184.

§ 3.740 Maximum structural cruising speed (Vno). This operating limitation shall be:

(a) Not greater than Vc chosen in accordance with § 3.184.

(b) Not greater than 0.89 times Vne established under § 3.739.

(c) Not less than the minimum Vc permitted in § 3.184.

§ 3.741 Maneuvering speed (Vp). (See § 3.184.)

§ 3.742 Flaps-extended speed (Vfe).

(a) This speed shall not exceed the lesser of the following:

(1) The design flap speed, Vf chosen in accordance with § 3.190.

(2) The design flap speed chosen in accordance with § 3.223, but shall not be less than the minimum value of design flap speed permitted in §§ 3.190 and 3.223.

(b) Additional combinations of flap setting, air speed, and engine power may be established, provided the structure has been proven for the corresponding design conditions.

§ 3.743 Minimum control speed (Vmc).(See § 3.111.)

POWER PLANT

§ 3.744 Power plant. The power plant limitations in §§ 3.745 through 3.747 shall be established and shall not exceed the corresponding limits established as a part of the type certification of the engine and propeller installed in the airplane.

§ 3.745 Take-off operation.

(a) Maximum rotational speed (revolutions per minute).

(b) Maximum permissible manifold pressure (if applicable).

(c) The time limit upon the use of the corresponding power.

(d) Where the time limit of paragraph (c) of this section exceeds 2 minutes, the maximum allowable temperatures for cylinder head, oil, and coolant outlet if applicable.

§ 3.746 Maximum continuous operation,

(a) Maximum rotational speed (revolutions per minute).

(b) Maximum permissible manifold pressure (if applicable).

(c) Maximum allowable temperatures for cylinder head, oil, and coolant outlet if applicable.

§ 3.747 Fuel octane rating. The minimum octane rating of fuel required for satisfactory operation of the power plant at the limits of §§ 3.745 and 3.746.

AIRPLANE WEIGHT

§ 3.748 Airplane weight. The airplane weight and center of gravity limitations are those required to be determined by § 3.71.

MINIMUM FLIGHT CREW

§ 3.749 Minimum flight crew. The minimum flight crew shall be established as that number of persons required for the safe operation of the airplane during any contact flight as determined by the availability and satisfactory operation of all necessary controls by each operator concerned.

TYPES OF OPERATION

§ 3.750 Types of operation. The type of operation to which the airplane is limited shall be established by the category in which it has been found eligible for certification and by the equipment installed. (See Parts 42 and 43 of this chapter.)

MARKINGS AND PLACARDS

§ 3.755 Markings and placards.

(a) The markings and placards specified are required for all airplanes. Placards shall be displayed in a conspicuous place and both shall be such that they cannot be easily erased, disfigured, or obscured. Additional informational placards and instrument markings having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant.

(b) When an airplane is certificated in more than one category, the applicant shall select one category on which all placards and markings on the airplane shall be based. The placard and marking information for the other categories in which the airplane is certificated shall be entered in the Airplane Flight Manual. A reference to this information shall be included on a placard which shall also indicate the category on which the airplane placards and markings are based.

INSTRUMENT MARKINGS

§ 3.756 Instrument markings. The instruments listed in §§ 3.757-3.761 shall have the following limitations marked thereon. When these markings are placed on the cover glass of the instrument, adequate provision shall be made to maintain the correct alignment of the glass cover with the face of the dial. All arcs and lines shall be of sufficient width and so located as to be clearly and easily visible to the pilot.

§ 3.757 Air-speed indicator.

(a) True indicated air speed shall be used:

(1) The never-exceed speed, Vne—a radial red line (see § 3.739).

(2) The caution range—a yellow arc extending from the red line in (1) above to the upper limit of the green arc specified in (3) below.

(3) The normal operating range—a green arc with the lower limit at Vs1, as determined in § 3.82 with maximum weight, landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed established in § 3.740.

(4) The flap operating range—a white arc with the lower limit at Vso as determined in § 3.82 at the maximum weight, and the upper limit at the flaps-extended speed in § 3.742.

(b) When the never-exceed and maximum structural cruising speeds vary with altitude, means shall be provided which will indicate the appropriate limitations to the pilot throughout the operating altitude range.

§ 3.758 Magnetic direction indicator. A placard shall be installed on or in close proximity to the magnetic direction indicator which contains the calibration of the instrument in a level flight attitude with engine(s) operating and radio receiver(s) on or off (which shall be stated). The calibration readings shall be those to known magnetic headings in not greater than 30-degree increments.

§ 3.759 Power-plant instruments. All required power-plant instruments shall be marked with a red radial line at the maximum and minimum (if applicable) indications for safe operation. The normal operating ranges shall be marked with a green arc which shall not extend beyond the maximum and minimum limits for continuous operation. Take-off and precautionary ranges shall be marred with a yellow arc.**[**Ranges of engine speed which are restricted as a result of excessive engine or propeller vibration shall be marked with a red arc.**]**

§ 3.760 Oil quantity indicators. Indicators shall be suitably marked in sufficient increments so that they will readily and accurately indicate the quantity of oil.

§ 3.761 Fuel quantity indicator. When the unusable fuel supply for any tank exceeds 1 gallon or 5 percent of the tank capacity, whichever is greater, a red band shall be placed on the indicator extending from the calibrated zero reading (see § 3.437) to the lowest reading obtainable in the level flight attitude, and a suitable notation in the Airplane Flight Manual shall be provided to indicate the flight personnel that the fuel remaining in the tank when the quantity indicator reaches zero cannot be used safely in flight. (See § 3.672.)

CONTROL MARKINGS

§ 3.762 General. All cockpit controls, with the exception of the primary flight controls, shall be plainly marked as to their function and method of operation.

§ 3.763 Aerodynamic controls. The secondary controls shall be suitably marked to comply with §§ 3.337 and 3.338.

§ 3.764 Power-plant fuel controls.

(a) Controls for fuel tank selector valves shall be marked to indicate the position corresponding to each tank and to all existing cross feed positions.

(b) When more than one fuel tank is provided, and if safe operation depends upon the use of tanks in a specific sequence, the fuel tank selector controls shall be marked adjacent to or on the control to indicate to the flight personnel the order in which the tanks must be used.

(c) On multiengine airplanes, controls for engine valves shall be marked to indicate the position corresponding to each engine.

(d) The capacity of each tank shall be indicated adjacent to or on the fuel tank selector control.

§ 3.765 Accessory and auxiliary controls.

(a) When a retractable landing gear is used, the indicator required in § 3.359 shall be marked in such a manner that the pilot can ascertain at all times when the wheels are secured in the extreme positions.

(b) Emergency controls shall be colored red and clearly marked as to their method of operation.

MISCELLANEOUS

§ 3.766 Baggage compartments, ballast location, and special seat loading limitations.

(a) Each baggage or cargo compartment and ballast location shall bear a placard which states the maximum allowable weight of contents and, if applicable, any special limitation of contents due to loading requirements, etc.

(b) When the maximum permissible weight to be carried in a seat is less than 170 pounds (see § 3.74), a placard shall be permanently attached to the seat structure which states the maximum allowable weight of occupants to be carried.

§ 3.767 Fuel, oil, and coolant filler openings. The following information shall be marked on or adjacent to the filler cover in each case:

(a) The word "fuel," the minimum permissible fuel octane number for the engines installed, and the usable fuel tank capacity. (See § 3.437.)

(b) The word "oil" and the oil tank capacity.

(c) The name of the proper coolant fluid and the capacity of the coolant system.

§ 3.768 Emergency exit placards. Emergency exit placards and operating controls shall be colored red. A placard shall be located adjacent to the control(s) which clearly indicates it to be an emergency exit and describes the
method of operation. (See § 3.387.)

§ 3.769 Approved flight maneuvers—

(a) Category N. A placard shall be provided in front of and in clear view of the pilot stating: "No acrobatic maneuvers including spins approved."

(b) Category U. A placard shall be provided in front of and in clear view of the pilot stating: "No acrobatic maneuvers approved, except those listed in the Airplane Flight Manual."

(c) Category A. A placard shall be provided in clear view of the pilot which lists all approved acrobatic maneuvers and the recommended entry air speed for each. If inverted flight maneuvers are not approved, the placard shall bear a notation to this effect.

§ 3.770 Airplane category placard. A placard shall be provided in front of and in clear view of the pilot stating: "This airplane must be operated as a ----------------- or --------------- category airplane in compliance with the Airplane Flight Manual."

AIRPLANE FLIGHT MANUAL

§ 3.777 Airplane Flight Manual. An Airplane Flight Manual shall be furnished with each airplane. The portions of this document listed below shall be verified and approved by the Administrator, and shall be segregated, identified, and clearly distinguished from portions not so approved. Additional items of information having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant.

§ 3.778 Operating limitations—

(a) Airspeed limitations. Sufficient information shall be included to permit proper marking of the airspeed limitations on the indicator as required in § 3.757. It shall also include the design, maneuvering speed, and the maximum safe air speed at which the landing gear can be safely lowered. In addition to the above information, the significance of the air speed limitations and of the color coding used shall be explained.

(b) Power-plant limitations. Sufficient information shall be included to outline and explain all power-plant limitations (see § 3.744) and to permit marking the instruments as required in § 3.759.

(c) Weight. The following information shall be included:

(1) Maximum weight for which the airplane has been certificated,

(2) Airplane empty weight and center of gravity location,

(3) Useful load,

(4) The composition of the useful load, including the total weight of fuel and oil with tanks full.

(d) Load distribution.

(1) All authorized center of gravity limits shall be stated. If the available space for loading the airplane is adequately placarded or so arranged that any reasonable distribution of the useful load listed in weight above will not result in a center of gravity location outside of the stated limits, this section need not include any other information than the statement of center of gravity limits.

(2) In all other cases this section shall also include adequate information to indicate satisfactory loading combinations which will assure maintaining the center of gravity position within approved limits.

(e) Maneuvers. All authorized maneuvers and the appropriate air-speed limitations as well as all unauthorized maneuvers shall be included in accordance with the following:

(1) Normal category. All acrobatic maneuvers, including spins, are unauthorized. If the airplane has been demonstrated to be characteristically incapable of spinning in accordance with § 3.124 (d), a statement to this effect shall be entered here.

(2) Utility category. All authorized maneuvers demonstrated in the type flight tests shall be listed, together with recommended entry speeds. All other maneuvers are not approved. If the airplane has been demonstrated to be characteristically incapable of spinning in accordance with § 3.124 (d), a statement to this effect shall be entered here.

(3) Acrobatic category. All approved flight maneuvers demonstrated in the type flight tests shall be included, together with recommended entry speeds.

(f) Flight load factor. The positive limit load factors made good by the airplane's structure shall be described here in terms of accelerations.

(g) Flight crew. When a flight crew of more than one is required to operate the airplane safely, the number and functions of this minimum flight crew shall be included.

§ 3.779 Operating procedures. This section shall contain information concerning normal and emergency procedures and other pertinent information peculiar to the airplane's operating characteristics which are necessary to safe operation.

§ 3.780 Performance information.

[(a) For airplanes with a maximum certificated take-off weight of more than 6,000 lbs. information relative to the items of performance set forth in subparagraphs (1) through (5) of this paragraph shall be included. **]**

(1) The stalling speed, Vso, at maximum weight,

(2) The stalling speed, Vs1, at maximum weight and with landing gear and wing flaps retracted,

(3) The take-off distance determined in accordance with § 3.84, including the air speed at the 50-foot height, and the airplane configuration, if pertinent,

(4) The landing distance determined in accordance with § 3.86, including the airplane configuration, if pertinent,

(5) The steady rate of climb determined in accordance with § 3.85 (a), (c), and, as appropriate, (b), including the air speed, power, and airplane configuration, if pertinent.

(b) The effect of variation in (a) (2) with angle of bank up to 60 degrees shall be included.

(c) The calculated approximate effect of variations in subparagraphs (3), (4) and (5) of this paragraph with altitude and temperature shall be included.

SUBPART H—IDENTIFICATION DATA

§ 3.791 Identification plate. A fireproof identification plate shall be securely attached to the structure in an accessible location where it will not likely be defaced during normal service. The identification plate shall not be placed in a location where it might be expected to be destroyed or lost in the event of an accident. The identification plate shall contain the identification data required by **[**§ 1.50**.]**

§ 3.792 Airworthiness certificate number. The identifying symbols and registration numbers shall be permanently affixed to the airplane structure in compliance with **[**§ 1.100 **]** of this chapter.